The development of Hopscotch: an early intervention programme to improve motor skills and academic performance of grade R children in the West Coast of South Africa.

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Declaration

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This dissertation includes two original papers published in peer-reviewed journals and two unpublished publications. The development and writing of the papers (published and unpublished) were the principal responsibility of myself and, for each of the cases where this is not the case, a declaration is included in the dissertation indicating the nature and extent of the contributions of co-authors.

Abstract

There is a high incidence of motor skill impairment in low socio-economic areas. Motor skill impairment among pre-school children effects their functional development, including play, social development, and academic skills and progress. These children need therapeutic input; however, therapy resources are often not accessible and motor skill impairment may remain unrecognised and untreated.

This study aims to develop an accessible evidence-based motor skill intervention for grade R children in a rural low socio-economic area of South Africa, namely the West Coast.

It is a five-stage study with a sequential mixed-methods design and using the theoretical model of complex intervention development. Firstly, in the absence of prevalence data for motor skill impairment in South Africa, a prevalence study using a cross-sectional descriptive study design and multi-stage cluster sampling was conducted. The study showed a high prevalence of motor skill impairment at 14.5%. Significant influencing factors identified were gender (male), lack of playground equipment, low weight and height and low socio-economic status of an area.

Next, a scoping review was conducted to investigate the key elements of motor skill interventions for pre-school children. The PRIMA-SCR design was used to identify 45 studies through structured data-base searches, followed by title and abstract screening according to inclusion and exclusion criteria. The identified key elements were summarised in a proposed framework for intervention planning. A three-round Delphi study conducted with experts in the field of motor skill intervention followed on from the scoping review. The aim was to determine what the components of a feasible, cost effective motor skill intervention for pre-school children in the rural low socio-economic West Coast area would be. Consensus was reached at 75% or mean >4. A school-based, small-group intervention, facilitated by teachers under guidance and supervision of therapists was proposed.

The Hopscotch motor skill intervention programme was subsequently developed, following on from the informative reviews. The result is a cost effective, school-based, 12 week intervention. A task-shifting approach was adopted where teachers facilitate the programme under the supervision of therapists. The study concludes with a protocol paper for an exploratory randomised controlled trial to determine the preliminary effect of the Hopscotch

programme. A cluster randomised stepped wedge trial design is proposed to provide two randomised clusters of schools the opportunity to potentially benefit from the programme. It is envisaged that further research to evaluate the intervention will follow the pilot study.

The Hopscotch motor skill-intervention programme may be a feasible solution to provide children in rural low socio-economic areas with much needed cost-effective, yet high quality intervention. The development of this complex intervention is a fluid, ongoing process and its preliminary effect is yet to be determined. The outcomes of this study suggests further research in the areas of culturally sensitive screening tools, inclusivity of intervention groups and feasibility of roll-out to other areas.

Opsomming

Daar is 'n hoë voorkoms van motoriese vaardigheidsinperkings in lae sosio-ekonomiese gebiede. Motoriese vaardigheidsinperkings onder voorskoolse kinders beïnvloed hul funksionele ontwikkeling, insluitend spel, sosiale ontwikkeling en akademiese vaardighede en vordering. Hierdie kinders het terapeutiese insette nodig; terapiehulpbronne is egter dikwels nie toeganklik nie en motoriese inperkings kan ongediagnoseerd en onbehandeld bly.

Die doel van hierdie studie is om 'n toeganklike bewysgebaseerde motoriese vaardigheidsintervensie te ontwikkel vir graad R-kinders in 'n landelike, lae sosio-ekonomiese gebied van Suid-Afrika naamlik die Weskus. Die vyf-fase studie het 'n opeenvolgende ontwerp van gemengde metodes gebruik, asook die teoretiese model van komplekse intervensie-ontwikkeling. Eerstens, in die afwesigheid van prevalensiedata vir motoriese vaardigheidsinperking in Suid-Afrika, is 'n prevalensiestudie gedoen met behulp van 'n deursnee-beskrywende studie-ontwerp en 'n meerfasige steekproefneming. Die studie het 'n hoë voorkoms van motoriese vaardigheidsinperkings getoon met 14.5%. Belangrike faktore wat geïdentifiseer is, was geslag (manlik), gebrek aan speelgrondtoerusting, lae gewig en lengte en lae sosio-ekonomiese status van 'n gebied.

Vervolgens is 'n bestekopname-ondersoek gedoen om die sleutelelemente van motoriese vaardigheidsintervensies vir voorskoolse kinders te ondersoek. Die PRIMA-SCR-ontwerp is gebruik om 45 studies te identifiseer deur gestruktureerde databasis-soektogte, gevolg deur titel- en abstrakte sifting volgens insluiting- en uitsluitingskriteria. Die geïdentifiseerde sleutelelemente is saamgevat in 'n voorgestelde raamwerk vir intervensiebeplanning. ‘n Drie-rondte Delphi-studie wat uitgevoer is met kundiges op die gebied van motoriese vaardigheidsintervensie, het gevolg op die bestekopname. Die doel was om vas te stel wat die komponente van 'n haalbare, koste-effektiewe motoriese vaardigheidsintervensie vir voorskoolse kinders in die plattelandse lae-sosio-ekonomiese Weskusgebied sou wees. Konsensus is bereik op 75% of gemiddeld > 4. 'n Skoolgebaseerde, klein-groepintervensie, wat deur onderwysers onder leiding en toesig van terapeute gefasiliteer word, is voorgestel.

Die Hopscotch-intervensieprogram vir motoriese vaardighede is vervolgens ontwikkel na aanleiding van die bestekopname-ondersoek en Delphi-studie resultate. Die resultaat is 'n koste-effektiewe, skoolgebaseerde, twaalf weke intervensie. 'n Taakverskuiwende benadering is gevolg waar onderwysers die program onder toesig van terapeute fasiliteer. Die studie

word afgesluit met 'n protokol vir 'n loodsstudie om die voorlopige effek van die Hopscotch-program te bepaal. 'n Gerandomiseerde stap-wigproef-ontwerp word voorgestel om twee gerandomiseerde skoolgroepe die geleentheid te bied om moontlike voordeel uit die program te trek. Die vooruitsig is dat verdere ondersoek om die intervensie te evalueer, die loodsstudie sal volg.

Die Hopscotch-motoriese vaardigheidsintervensieprogram kan 'n haalbare oplossing wees om kinders in landelike lae-sosio-ekonomiese gebiede broodnodige koste-effektiewe, dog hoë gehalte intervensie te bied. Die ontwikkeling van hierdie komplekse intervensie is 'n vloeiende, deurlopende proses en die voorlopige effek daarvan moet nog bepaal word. Die uitkomste van hierdie studie dui op verdere navorsing op die gebied van kultuursensitiewe-siftingsinstrumente, inklusiwiteit van intervensiegroepe en uitvoerbaarheid van implementering in ander gebiede.

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Glossary

Activity oriented approach: A therapy approach where the aim is to improve performance in a specific activity (Smits-Engelsman et al., 2018)

Attention Deficit and Hyperactivity Disorder: A condition associated with an ongoing pattern of hyperactivity, impulsivity and/or inattention that interferes with general functioning or development (Ziereis & Jansen, 2015).

Autism spectrum disorder: A developmental disorder that affects social-communication skills and behaviour (MacDonald et al., 2014) .

Ayers' sensory integration®: Describes the process as originally researched by Jean Ayers by which children register, modulate, and discriminate sensory information received through the sensory systems resulting in purposeful, adaptive behaviours in response to their environment (Lane et al., 2019)

Body-function oriented approach: A therapy approach, where the aim is to reduce impairment and improve body function (Smits-Engelsman et al., 2018).

Cognitive Orientation to Occupational Performance: A performance-based cognitive therapy where the aim is on skill acquisition, generalisation and transfer of functional skills (Rodger et al., 2007).

Complex Intervention Development: A model of intervention development for interventions with interacting, unique and complex components. The model consists of a developmental, pilot, evaluation and implementation phase (Skivington et al., 2018).

Developmental Coordination Disorder: A specific developmental disorder of motor skill impairment, which cannot solely be explained by an intellectual disability, acquired neurological condition or congenital disorder (Blank et al., 2019).

Dynamic systems theory: A theory that describes movement as an interaction between the child, the environment, and the task at hand (Zwicker & Harris, 2009)

Executive function: The set of cognitive processes that enables a child to plan, focus attention, remember instructions and execute multiple tasks successfully (Cameron et al., 2016).

Foetal Alcohol syndrome: An irreversible condition that results from pre-natal alcohol exposure causing neurological damage and growth problems (O'Leary, 2004).

General Abilities Approach: A therapy approach based on the assumption that sensory and motor functions provide a platform for later motor and intellectual development (Sugden & Dunford, 2007)

Grade R: The final pre-school year before formal schooling starts in grade 1 in South Africa.

Kinderkineticists: A movement specialist in South Africa who aims to promote and optimise the neuromotor development of children through scientifically based physical activity.

Kinesiologists: Movement specialists who aim to improve the efficiency and performance of the human body while a person is at work or at play by studying the factors that influence human movement.

Motor Learning Theory: A theory of motor skill development through practice and repetition for transfer to other tasks and areas (Case-Smith et al., 2013).

Motor skill impairment: A term to describe concerns with motor skill development caused by specific health conditions or as a hidden disability (Brown et al., 2018; Doney et al., 2014; Rafie et al., 2017; Vaivre-Douret, 2014). For this study, it encompasses the terms motor impairment, motor difficulties and motor skill difficulties.

Motor skill competence: The acquisition of age appropriate and functional motor skills (Sugden & Chambers, 2007; True et al., 2017).

Neuro Developmental Treatment (NDT): A specialised neurological therapy approach which aims to improve gross motor function in children with neurological problems to improve independence in a variety of contexts (Brown & Burns, 2001).

Neuromotor Task Training: A neuro-based therapy approach where emphasis is placed on the interaction between the child, the task and the social and physical environment, with the aim being the achievement of a desired movement goal (Brown & Burns, 2001).

Normative Function Approach: A therapy approach that focuses on functional skills, rather than underlying processes (Bond, 2011).

Perceptual Motor Treatment: For the purpose of this study, the term includes general abilities approaches and methods where the focus is on learning skills that require linking perceptual/spatial skills with appropriate motor responses (Pless & Carlsson, 2000; Sugden & Dunford, 2007).

Task-Specific Training: A therapy approach with the focus on repetitive practice of a meaningful motor skill-based activity that is specific to an intended outcome (Cavalcante Neto et al., 2020).

Task-shifting: The process in health and rehabilitation domains where non-specialists with little or no prior training or experience in a certain area provide treatment in that area under supervision (World Health Organization, 2008).

Visual Motor Integration: The integration of visual perceptual and motor skills (Sugden & Dunford, 2007).

Visual Perception: Refers to the ability to interpret what is visually observed (Haapala et al., 2014). It includes visual figure/ground, visual form constancy, visual discrimination, visual spatial relationships, visual closure and visual memory.

Abbreviations

ADHD: Attention Deficit and Hyperactivity Disorder

AIDS: Acquired Immunodeficiency Syndrome

ASD: Autism Spectrum Disorder

ASI: Ayers Sensory Integration®

BOTMP: Bruininks-Oseretsky Test of Motor Proficiency

CAPS: National Curriculum and Assessment Policy Statement

CMP: Complementary Models of Practice

CNS: Central Nervous System

CO-OP: Cognitive Orientation to Occupational Performance

CP: Cerebral Palsy

DCD: Developmental Coordination Disorder

DCDQ: Developmental Coordination Disorder Questionnaire

FAS: Foetal Alcohol Syndrome

GAA: General Abilities Approaches

GMFM: Gross Motor Function Measure

HIV: Human Immunodeficiency Virus

HREC: Health and Research Ethics Committee

J-MAP: Miller's assessment for pre-schoolers

LMIC: Low- and middle-income countries

MABC: Movement Assessment Battery for Children

MABC-2: Movement Assessment Battery for Children second edition

MRC: Medical Research Council

NDT: Neuro Developmental Therapy

NHMRC: National Health and Medical Research Council

NTT: Neuromotor Task Training

OMP: Organising Model of Practice

PDMS: Peabody Developmental Motor Scales

PMT: Perceptual-Motor Treatment

RCT: Randomised Controlled Trial

SES: Socio-economic status

TGMD: Test of Gross Motor Development

SI: Sensory Integration

SPSS: Statistical package for social sciences

TST: Task-Specific Training

VMI: Developmental Test of Visual Motor Integration

VPM: Visual-perceptual motor

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SECTION 1

INTRODUCTION

Chapter 1

Introduction

This dissertation describes the development of a motor skill intervention for grade R children on the West Coast of South Africa – a rural, predominantly low socio-economic region located in the Western Cape. Many children on the West Coast do not have access to much needed therapeutic services to address developmental delays, including motor skill impairment. It is hypothesised that an accessible and affordable motor skill intervention strategy may raise awareness about motor skill impairment, help with early identification of difficulties, and improve motor skills and, subsequently, academic proficiency among young children.

This chapter (Chapter 1) first provides a background to the study, by considering the concept of motor skill impairment, its prevalence, and assessment and intervention thereof. Then the context of this research is introduced before an overview of the research process is presented. The chapter concludes with an overview of the structure of this dissertation.

Background

The pre-school years of any child's life is a crucial time to lay down foundations of development for participation in school on an academic, social, functional and emotional level. Physical activity and motor learning are part of this development and influence participation in everyday activities of childhood (Blank et al., 2019; Polatajko & Cantin, 2005). When there is a delay or impairment in motor skill development, a child's independence with regards to these activities and skills may be affected (Missiuna et al., 2008; van der Linde et al., 2015). To define the problem, the key concepts involved, namely motor skill impairment, its link to learning and academic skills, and the influence of socio-economic factors are first described. Available prevalence data, known assessment and intervention approaches and methods, including accessibility to these interventions, are discussed in this section. The West Coast region, including school and therapy demographics of the area, is also presented to help contextualise and motivate the need for this study.

There is ambiguity in the literature about what constitutes motor skill competence (Rudd et al., 2016). Robinson (2015) suggested that the term is used globally and includes motor proficiency, motor performance, fundamental movement skills, motor ability and motor co-ordination (Robinson et al., 2015). In this study, motor skill competence refers to the level at

which a child can execute motor skills on a functional level (Sugden & Chambers, 2007; True et al., 2017). In a child's grade R year (age 5–7), early developmental milestones have been reached in a reasonable, consistent sequence, primitive reflexes are mostly integrated and basic postural control and coordination are in place (Haywood & Getchell, 2014). By age five, children are presumed ready to perform skilled and coordinated actions such as walking on a line, hopping, climbing and negotiating various playground equipment, riding a bicycle and participating in ball games (Sheridan, 1997). While these movements relate to larger body movement or gross motor skills, Sheridan's (1997) developmental hierarchy also describes motor skills relating to vision and fine movements (fine motor skills). A child of five can usually manipulate minute objects, build elaborate building brick models, draw and paint with good control and colour within the lines. These gross and fine motor skills are important prerequisites for independence in everyday living activities, socialisation and behaviour and academic skills in preparation for school readiness (Blank et al., 2019; Missiuna et al., 2008).

The terms "motor impairment" and "motor skill impairment" are used interchangeably in the literature to describe dysfunctions of the motor and neuro-musculoskeletal systems (Brown et al., 2018; Doney et al., 2014; Rafie et al., 2017; Vaivre-Douret, 2014). Motor impairment has multiple causes, including spasticity, as seen in Cerebral Palsy (CP) (Park & Kim, 2013) and muscle weakness associated with many physical disabilities (Martin et al., 2010). Developmental Coordination Disorder (DCD) is a specific developmental disorder of motor function frequently described as motor skill impairment, which cannot solely be explained by an intellectual disability, acquired neurological condition or congenital disorder (Blank et al., 2019). In addition, motor skill impairment is also associated with Attention Deficit and Hyperactivity Disorder (ADHD) (Ziereis & Jansen, 2015), Foetal Alcohol syndrome (FAS) (Doney et al., 2017; Olivier et al., 2013), some speech and language disorders (Adi-Japha et al., 2011), Autism Spectrum Disorder (ASD) (MacDonald et al., 2014) and Human Immunodeficiency Virus (HIV)/Acquired Immunodeficiency Syndrome (AIDS) (Ferguson & Jelsma, 2009). When referring to these developmental disorders, the terms "motor difficulties" or "motor skill difficulties" are also commonly used (Bond et al., 2011; van Cappellen-van Maldegem et al., 2018). Throughout this dissertation, the term motor skill impairment is used to denote motor impairment, motor difficulties and/or motor skill difficulties caused by specific health conditions or as a hidden disability (Lingam et al., 2009).

The identification of motor skill impairment in pre-school years is important given its association with learning disabilities (Michel et al., 2011; Pagani & Fitzpatrick, 2013). When children present with conditions such as prematurity and very low birth weight (Dewey et al., 2011; Moreira et al., 2014) or congenital disorders such as Down's Syndrome (Palisano et al., 2001), motor skill development is usually routinely monitored. In contrast, motor skill impairment associated with conditions such as DCD are often underdiagnosed and unrecognised (Camden et al., 2015). Difficulties around motor skill development are often only identified at a school-going age (Dewey & Wilson, 2001). Even then, parents and teachers do not always have the experience and knowledge to identify coordination and motor skill impairment (Missiuna, Pollock, Levac et al., 2012) and children may continue through their school years without the necessary intervention. It can be assumed that these developmental conditions are even less recognised in areas where therapy services are not readily available or accessible.

Fine motor skills, together with executive function in the pre-school years, have consistently been identified as predictors of academic skills such as maths, reading and science performance in later school years (Grissmer et al., 2010; Kim et al., 2018; Roebers et al., 2014). For a child to function in a pre-school or grade R class, motor coordination, executive function and visual-spatial skills need to correlate to ensure a good foundation for learning (Cameron et al., 2016). A study among first grade South African children found that there is a close relationship between visual-motor integration, visual perception, hand control and motor proficiency and basic academic skills needed for academic functioning in the first year of formal schooling, and poorer motor skills were associated with lower academic achievement (Haapala et al., 2014). Another study found that there is a link between the severity of motor impairment and the learning gap of children who experience difficulties with learning (Westendorp et al., 2011). More recently, gross motor skill development has been linked to the academic skills of spelling and reading (Botha & Africa, 2020). These difficulties can continue through secondary school (Harrowell et al., 2018) and adulthood (Tal-Saban et al., 2012) when not addressed.

Early academic performance may predict future educational achievement. A study by Entwistle et al. (2005) found that a child's academic performance in grade 1 (associated with race, gender, socio-economic status and neighbourhood quality) can predict educational achievement by age 22. This study from Baltimore, United States of America (USA)

followed 790 children from their grade 1 year in 1982, into early adulthood at age 22. Children's basic academic skills were assessed, while teachers were asked to rate children's temperament and assign marks for reading and maths at the end of the year. Sixteen years on, the students' academic achievement was followed-up through the Young Adults Survey, while face to face or telephonic interviews were conducted at age 22 (Entwisle et al., 2005). It was concluded that where inequality was experienced as affecting academic skills, this was maintained through to - at least - early adulthood.

Similarly, Rabiner et al. (2016) found that reading ability, social skills and attention were predictors of long-term academic outcomes. Their study focussed on 386 non-intervention pre-school children from a previous multi-site clinical trial across several states in USA that focussed on conduct intervention. Measures of early academic skills, attention skills and social competence were used as predictor variables, with intelligence, race and socio-economic status (SES) as control variables. Academic achievement was followed up at grade 5 and grade 8 through the Schools Archived Records Search and at age 24–25 through a paper or online survey (Rabiner et al., 2016). This study found that early academic and social difficulties significantly reduced the number of years young adults advanced in education.

Although these two studies are representative of the USA population, findings were consistent and reconfirm the importance of early intervention. Considering the link between motor skill proficiency and early academic skills, early identification of, and intervention for, motor skills impairment is paramount to improve health, education and later employment possibilities for children, especially in low socio-economic areas (Manacorda, 2012; Venter & Bham, 2003).

Prevalence of Motor Skill Impairment

Multiple standardised measures are used to detect motor skill impairment. Outcome measures most commonly referred to in research include the Peabody Developmental Motor Scales (PDMS) (Bazyk et al., 2009; Colombo-Dougovito & Block, 2019), Test of Gross Motor Development (TGMD) (Bardid et al., 2013; Ketcheson et al., 2017), Movement Assessment Battery for Children (MABC) (van Cappellen-van Maldegem et al., 2018; Ward et al., 2017), Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) (Najafabadi et al., 2018; Wuang et al., 2010), Miller's assessment for pre-schoolers (J-MAP) (Colombo-Dougovito & Block, 2019; Golos et al., 2011; Iwanaga et al., 2014; Najafabadi et al., 2018), Gross Motor Function Measure (GMFM) (Salem et al., 2012) and the Developmental Test of Visual Motor

Integration (VMI) (Golos et al., 2011; Lahav et al., 2008). Recent studies have explored the accuracy of parental and teacher screening tools such as the MABC-2 and Developmental Coordination Disorder Questionnaire (DCDQ) screening questionnaires, with mixed outcomes (De Milander et al., 2019; Pek et al., 2009; Potterton et al., 2010; Prado et al., 2009).

International studies show that the prevalence of motor skill impairment varies greatly across the globe, with the most frequent reported number being 5%–6% (Blank et al., 2019). Nevertheless, research also consistently shows that socio-economic status is associated with motor skill competence. A study in Kolkata, India, identified chronic malnutrition and low SES as factors associated with motor proficiency, as measured with the BOTMP in children aged 5–12 years (Ghosh et al., 2016). A South African study similarly found negative association between low SES school types, perceptual-motor foundation skills and academic performance, and (Pienaar et al., 2014). They used the VMI and BOTMP (short form) to assess visual motor integration and motor skill proficiency. A study in a low socio-economic area of Brazil determined a high prevalence of DCD or probable DCD for children at 33% (Valentini et al., 2015) using the Movement Assessment Battery for Children (MABC). A score below the 15th percentile of the MABC was used to indicate a risk of significant motor skill impairment. Similarly, a study in the Jiangsu province of China used the MABC to determine the prevalence of DCD among 3–6 year-old children at 15.6%. Low SES, together with the education level of parents and fluctuation between carers, were identified as parental risk factors (Jin et al., 2015).

These figures are high when compared to a United Kingdom (UK) based study indicating a DCD prevalence of 1.7% at age seven (Lingam et al., 2009) using the Diagnostic and Statistical Manual of Mental Disorders (4th edition) criteria. A recent overview of DCD research reported a DCD prevalence of up to 7% for school-aged children (Caçola & Lage, 2019). There are indications that low SES in high income countries such as the UK also significantly affects the development of motor skills (Morley et al., 2015).

No prevalence data were available for DCD or similar motor skill development conditions in South Africa at the onset of this study. Prevalence data for conditions commonly associated with motor skill impairment, however, suggest a high prevalence among children in South Africa. In a worldwide prevalence study of FAS, South Africa was found to have a high prevalence when compared to other countries (Roozen et al., 2016). The West Coast region

of South Africa has been identified as an area with a particularly high prevalence of this condition in school children (Olivier et al., 2013). To date, at least 11 FAS prevalence studies in four of South Africa's nine provinces have been conducted, with rates between 20 and 282 per 1000 grade 1 learners (Oliver, 2017). Another condition with a remarkably high prevalence in South Africa is HIV/Aids, with 260 000 children (0–14years) estimated to be living with HIV, according to 2018 data (Avert, 2020). There is a high prevalence of motor delay, reported to be at 65% for these children, as found in a study among young children (< 3 years) living with HIV in Cape Town (Ferguson & Jelsma, 2009). The COVID-19 pandemic, with resulting lockdowns and limitations, may well also impact on motor skill proficiency among young children in South Africa, however this is yet to be determined.

The paths taken to identify, diagnose and treat motor impairment vary and depend on each child's unique background, SES and geographical location. Literature on motor skill intervention most often refers to DCD: children are usually referred for motor skill intervention when there is a known condition affecting motor skill development; due to parental concerns; when there are associated behaviours noticed in the learning environment; and by professionals with a knowledge of DCD or motor skill impairments such as paediatricians, child psychiatrists or teachers (Kirby et al., 2014). In an international clinical practice recommendation for DCD, Blank et al. (2019) considered literature reviews and expert consensus to determine guidelines and recommend that a diagnosis is made by a medical professional or by a multi-disciplinary team.

Intervention depends on the severity of the problem and degree of interference with the child's everyday life, and ranges from formal therapy intervention, motor learning opportunities such as organised play, or advice to parents/teachers to implement suggestions at school/home with clinical supervision (Blank et al., 2019). In their study, Blank et al. (2019) refer to "therapists" in general, however children are most often referred to occupational therapists and physiotherapists for motor skills assessments and intervention (Smits-Engelsman et al., 2018). According to Forsyth et al. (2008), other health professionals involved include dieticians, podiatrists, speech and language therapists, orthoptists and orthotists (Forsyth et al., 2008). Kinesiologists are also concerned with the motor skill development of children (Inder & Sullivan, 2004; Valentini et al., 2017). In South Africa, kinderkineticists, who have a sports science background, focus on the development of children from a movement perspective (North-West University, 2020; Pienaar et al., 2011).

Blank et al. (2019) identified the DCDQ as the only screening questionnaire with a reliable level of evidence (Blank et al., 2019). However, an Australian study found that the DCDQ accurately identified children with moderate to severe motor skill impairment, but not children with milder motor skill impairments (Pek et al., 2009). A translated version of the questionnaire with cross-cultural adaptations was found to show potential as a screening tool for Brazilian children, however, further testing on a larger scale was recommended (Prado et al., 2009). A South African based study that used the DCDQ (Canadian version), together with the MABC-2 parent checklist and MABC-2 performance test to determine the accuracy of parents and teachers' observations, found that the parent questionnaires were not reliable as indicators of DCD. The culture-specificity of the Canadian version was thought to be a limitation in the study and further testing in other regions of South Africa was recommended (De Milander et al., 2019).

Approaches to Treatment

In line with the heterogeneity of motor skill impairments, many approaches and treatment methods to improve motor skill competence have been described in the literature (Blank et al., 2019). Overall, there has been a shift from process or deficit orientated approaches (Case-Smith et al., 2013; Sugden & Chambers, 2003; Zwicker et al., 2009), also described as general abilities approaches (Pless & Carlsson, 2000; Sugden & Dunford, 2007), to more contemporary theories of motor learning (Zwicker & Harris, 2009) and a normative function approach (Case-Smith et al., 2013; Sugden & Dunford, 2007). The latter focus on dynamic systems theory (Hillier, 2007; Zwicker & Harris, 2009).

Theories of general abilities approaches include Sensory Integration (SI) (also known as Ayers Sensory Integration® (ASI)), Neuro Developmental Treatment (NDT) and Perceptual Motor Training (PMT) (Pless & Carlsson, 2000; Zwicker & Harris, 2009). These theories are based on a hierarchical model of the Central Nervous System (CNS). However, since the late 1980s, the CNS is conceptualised as multilevel and multisystem, rather than hierarchical (Zwicker & Harris, 2009). General abilities approaches, with the underlying principle that by improving competency in sensory and neural areas transfer will occur to functional skills, however, remain popular among therapists, despite limited empirical evidence in the literature (Hong, 2020; Pfeiffer et al., 2017; Schaaf et al., 2017). Sugden (2007) argued that the lack of evidence for general abilities approaches may be related to the difficulty in determining the exact sensory or motor component of a specific skill.

A normative function approach focuses on functional skills, rather than underlying processes, and includes cognitive motor approaches and problem-solving models such as the Cognitive Orientation to Occupational Performance (CO-OP) (Polatajko et al., 2001), as well as task orientated approaches such as Task-Specific Training (TST) (Alloway & Warn, 2008) and Neuromotor Task Training (NTT) (Niemeijer et al., 2007). The dynamic systems theory describes movement as an interaction between the child, the environment, and the task at hand (Sugden, 2007; Zwicker & Harris, 2009). A systematic review of motor skill interventions for under five-year-olds (Case-Smith et al., 2013) showed that successful motor skill interventions included in their review were based on the dynamic systems theory and motor learning theory.

While approaches to treatment vary widely in the literature, treatment interventions appear to typically take place either in a group or through individual therapy sessions (Davies & Gavin, 1994; Dunford, 2011; Hung & Pang, 2010), through home programmes (Potterton et al., 2010; Ratzon et al., 2010; Shin & Nguyen Duc, 2017) or indirect intervention such as giving advice or feeding into a child's individual education plan (Dreiling & Bundy, 2003; Reid et al., 2006). Intervention can take place in a therapy environment, e.g., a clinic or therapy centre (Pfeiffer et al., 2011) or in the school environment (Reid et al., 2006; Bazyk et al., 2009). Although the theoretical frameworks underpinning intervention also vary, most seem to have a positive effect, as suggested in several systematic reviews (Hillier, 2007; Riethmuller et al., 2009; Smits-Engelsman et al., 2013). More recent systematic reviews which were published after the start of this study (Eddy et al., 2019; Preston et al., 2017; Smits-Engelsman et al., 2018), are more prescriptive in suggesting specific therapy approaches or models, although the focus remains on DCD.

Hillier (2007) included 31 studies ranging from 1970–2004 in her systematic review on intervention for children with DCD. All were classified as level I–III on the National Health and Medical Research Council (NH & MRC) levels of evidence. A meta-analysis was not conducted due to the heterogeneity of intervention approaches and outcome measures reported. More than 30 different treatment approaches were described, most commonly perceptual-motor therapy, sensory integration therapy and kinaesthetic training. These process orientated approaches differ as follow: perceptual-motor therapy refers to the development of gross and fine motor skills in combination with spatial awareness through practice (Sugden & Dunford, 2007). Sensory integration refers to the effect of sensory input

on the organisation of neurological processes involved with motor planning and motor learning (Lane et al., 2019). Kinaesthetic training focuses on repetitive practice of specific aspects of movements (Polatajko et al., 1995). The systematic review concluded that there was sufficient evidence of sufficient quality to suggest that any intervention is better than no intervention for children with DCD. However, further research regarding the effective factors in therapy approaches, as well as the pragmatics of service delivery, were recommended (Hillier, 2007).

A systematic review by Riethmuller et al. (2009) investigated the efficacy of interventions addressing motor development in children under five. Seventeen studies published after 1987 were included. These studies reported on motor skill interventions with clear objective outcome measures. Qualitative studies, studies without a control group and with less than 10 participants and programmes of less than four weeks in duration were excluded. A 10-item quality assessment tool was used to assess methodological quality. Sixty percent of studies were reported to be effective in significantly improving motor skills in pre-school children. However, each study was unique in design, length, instruction time and participants. Outcome measures varied and only three studies described an underlying theoretical approach. Riethmuller et al. (2009) concluded that the study highlighted the limited quantity and quality of motor skill interventions described to improve motor skills in pre-school children (Riethmuller et al., 2009).

A systematic review and meta-analysis by Smith-Engelsman et al. (2013) reviewed the efficacy of motor skill intervention for DCD. Twenty-six studies published between 1995 and 2011 were included. Only studies that reported on DCD or motor skill impairment, with clear motor outcome measures based on standardised assessments, were included. As in the previous two systematic reviews described, the review concluded that any intervention is beneficial for children with DCD, over and above no intervention. However, evidence suggested that task-oriented approaches, as normative function approaches, generated larger effects. In contrast, process-orientated approaches were not recommended for motor skill intervention in DCD (Smits-Engelsman et al., 2013). Preston et al's (2017) systematic review of high quality randomised controlled trials also concluded that task-oriented approaches are most effective when treating motor impairment in DCD. Only randomised controlled trials (RCT's) that scored seven or above on the Physiotherapy Evidence Database scale (PEDro)

were included in the review by Preston et al. (2017). Nine RCT's investigating 15 interventions were included in the study.

Smits-Engelsman et al. (2018), in their systematic review and meta-analysis (30 studies), aimed to examine recent evidence (2012–2017) regarding motor skill interventions for DCD. The review only included studies that used reliable standardised outcome measures. The strength of evidence was measured by evaluating the study quality (integrity of design and risk of bias), study quantity (the number of similar studies and number of participants) and consistency of outcomes (similarity between outcomes of studies of the same type). Approaches were re-categorised, encompassing both general abilities approaches and dynamic systems theories. Their review included recent literature which showed positive evidence for body-function oriented and activity-oriented approaches. However, it was recommended that body-function oriented approaches focus on activity engagement designed to improve the underlying targeted functional motor problems. Body-function, as described in Smith-Engelsman et al.'s (2018) review, refers to approaches where the aim was to reduce impairment and improve body-function, e.g., strength training or visual training (Smits-Engelsman et al., 2013), but combined with activity-based therapy. Activity-oriented approaches aim to improve performance in a specific activity and included NTT and CO-OP (Smits-Engelsman et al., 2018). An activity approach, would, for example, use bead-stringing as an activity to improve the skill of threading, while a body-function oriented approach would use bead-threading to improve eye-hand coordination to, for example, improve handwriting. The researchers, however, concluded that results should be interpreted with caution due to the variation in methodologies, as well as the large confidence intervals of some studies (Smits-Engelsman et al., 2018).

Another systematic review focussed on motor skill interventions in schools (Eddy et al., 2019). The review included 23 randomised and case-controlled trials of school-based motor skill interventions for children between the ages of three and 12. Records dated between 2012 and 2018 were included. Eddy et al. (2019) concluded that schools are an effective setting for motor skill interventions, with 19 of the 23 included studies reporting significant improvement of at least one aspect of motor proficiency. All interventions focussed on fundamental movement skills (FMS) or handwriting. As in the review by Smits-Engelsman et al (2018), interventions were categorised as activity oriented (handwriting interventions) or body-function oriented associated with FMS. Most studies were inclusive of the whole class

with only three studies exclusively including children with motor skill impairment. With biases evident in many included studies, one handwriting intervention as well as FMS interventions were found to be most effective. Further research was recommended with regards to the dosage, intensity and generalised vs targeted interventions (Eddy et al., 2019).

Researchers have also explored a range of alternative therapy methods with varied success, including aquatic therapy (Hillier et al., 2010), Taekwondo (Fong et al., 2012) and horse-riding or hippotherapy (Winchester et al., 2002; Hawkins et al., 2014).

The significant gap in these previous systematic reviews is the absence of studies including pre-school children from low- and middle-income countries (LMIC), including South Africa, which was classified as a LMIC at the onset of the study (The World Bank, 2021). There are in fact few studies that focus on motor skill interventions, especially for pre-school children with motor skill impairment in Africa. A quasi-experimental pre-test, post-test study by Erasmus et al. (2016) examined the effect of a perceptual-motor intervention on the school-readiness of children in a low socio-economic area in the North-West province of South Africa. All children in the class were included, with the focus on academic readiness rather than motor skills (Erasmus et al., 2016). It was found that children in the experimental group improved their school-readiness by 33.3% when tested with Le Roux's test for school-readiness, while 14.8% of children in the control group showed improvement.

Another randomised pre-test, post-test study examined the effect of a gross motor skill physiotherapy programme on the motor proficiency of children presenting with DCD in a remedial school in Durban, South Africa (Maharaj & Lallie, 2016). This randomised pre-test, post-test study found that MABC scores on gross motor tasks improved more for the experimental group, with significant improvements with the DCDQ. This was, however, a well-resourced school in an urban area with a team of therapy staff.

In a study among children attending early learning centres in Gugulethu and Alexandra, described by the authors as disadvantaged communities located in urban areas (mean age = 4.6), it was found that a fundamental movement skill programme (Little Champs), run over eight months, significantly improved the experimental group's locomotor, object control and cognitive skills when compared to a control group (Draper et al., 2012). This study's first part was a quasi-experimental study with post-test only, while the second part was a quasi-

experimental study with a pre-test, post-test control group design. The focus here was, however, on general development, rather than motor skill impairment.

A quasi-experimental pre-test post-test study by Ferguson et al. (2015) found that a health promotion programme implemented by undergraduate physiotherapy students in a low-income primary school in Cape Town, South Africa, improved motor skills of children with DCD (grade 1–5) and had a positive effect on the fitness level of all the children in the school (Ferguson et al., 2015).

The limited knowledge base of motor skill intervention in South Africa is perhaps influenced by the many challenges and constraints. Therapy is costly and resources are often limited (Sherry & Draper, 2013; Sonday et al., 2012). In South Africa, occupational therapy resources are very limited in the public sector (Ned et al., 2020), while physiotherapy services are mostly inaccessible to poorer communities (Narain & Mathye, 2019). While specialist paediatric teams are available in major hospitals such as the Red Cross War Memorial Children's Hospital (Western Cape Government, 2020a) in the Western Cape or the Nelson Mandela Children's Hospital in Gauteng (Nelson Mandela Children's Hospital Trust, 2019), occupational and physiotherapy services in general hospitals in more rural areas are limited and provide a general rather than specialised service (Naidoo et al., 2016). This implies a lack of paediatric expertise.

Context of this Research

An inclusive education system, as we have in South Africa, allows for children with various co-morbidities to attend mainstream schools (Republic of South Africa, 1996). However, access to therapy services within the education system is limited (Sonday et al., 2012). The education White Paper (nr. 5) of South Africa (2001) focuses on special needs and inclusive education (Department of Education, 2001), and mentions the optimising of experts, such as therapists, psychologists, remedial educators and health professionals. In the Western Cape, for example, specialised support services include psychology, social work, education therapy, learning support, positive behaviour programmes and clinical services (Western Cape Government, 2020b). There are, however, few occupational therapists within the education department who work in mainstream schools. On the West Coast, for example, there are 97 mainstream government primary schools, but only two occupational therapists employed by the Western Cape Education Department (WCED) to service these schools (Fourie, 2020, email correspondence, November 9, 2020). In addition, 70% of schools in the West Coast

district are no-fee schools, indicating low levels of income, high unemployment rates and poor level of education in the communities (Sayed & Motala, 2012).

The West Coast of South Africa is a vast area that spreads over 31 099 square kilometres (West Coast District Municipality, 2012), but is sparsely populated, with an average of 15 people per square kilometre (Western Cape Government, 2019). While assuming a general need for motor skill assessment and intervention throughout the school years, this study considered the importance of early intervention and school readiness and focussed on the 3969 grade R children (2016 statistics) in this area. The number of grade R learners per school on the West Coast varies from seven in a rural remote school, to 150 in an urban area, with a mode of 27 grade R learners per school, according to available statistics at the onset of the study (WCED, 2014). Most schools (83) use Afrikaans only as first language, nine schools are dual English/Afrikaans, while one school is dual Afrikaans/Xhosa and one school English/Xhosa. Three schools cater for Afrikaans, English and Xhosa languages. Schools are classified by location as urban main place (50), urban (23) or rural (23) and one school as main place. Although there is a wide range of assessments and interventions for motor skill impairment that have demonstrated effectiveness internationally, it is uncertain if and how these research advances would benefit children with motor skill impairment in South Africa, and on the West Coast in particular.

As an occupational therapist, the researcher views the development of motor skills and academic performance through the lens of occupation engagement in the first instance (Hammell & Iwama, 2012). As a paediatric therapist, the researcher focuses on play as the pre-school child's main occupation. Lynch & Moore (2016) describes play as a joyful and fun experience, which is intrinsically motivated and requires interaction between the child and the environment. They suggest that although play is used as a therapy tool in occupational therapy, play as a child's primary occupation should also be enabled in ways other than teaching or practicing play skills (Lynch & Moore, 2016). By designing context-specific interventions that enable and encourage participation in play, motor skill development is stimulated.

However, the researcher's experience as a paediatric therapist in the West Coast area over the past 10 years, leads to consideration of important context -specific issues and restraints. Access to play opportunities in the community is limited and although children create their own games, safety is often a concern (Bartie et al., 2016; Brown-Luthango et al., 2017).

Schools seems to be a safe and supervised location for play opportunities, however access to play equipment vary and communities may not have the resources, opportunity or ability to assist in improving or creating playgrounds (Chakaninka et al., 2012). The conclusion can thus be made that motor learning would be restricted because occupational engagement in play is limited by many restraints and limitations experienced with regards to resources and expertise in the West Coast.

Overview of the Research Process

Problem Statement

The increased risk for motor skill impairment in areas of socio-economic disadvantage, and inaccessibility to therapy services in South Africa, highlight the gap in provision of high-quality interventions that will make a difference in the lives of children with motor skill impairment. Without intervention, these children are at risk of developing long-term academic, social and behavioural difficulties. With the prevalence of various conditions associated with motor skills impairment estimated to be high on the West Coast, a multi-professional approach seems to be indicated. While some services are available in our public healthcare and education systems, they are thinly spread with many constraints. A cost-effective and accessible, yet comprehensive evidence-based motor skills intervention programme that uses existing resources and that forms part of the normal academic pre-school programme is needed.

Study Aim and Objectives

The aim of the study was to develop an intervention programme to improve the motor skills and academic performance of pre-school children in grade R (5–7 years) who present with motor skill impairment enrolled in government schools in the West Coast region of South Africa. The research question was:

What motor skill intervention programme design will be effective and feasible for children with motor skill impairment enrolled in grade R on the West Coast of South Africa to improve their motor and academic skills?

The specific objectives of the study to help answer the research question were the following:

1. To determine the prevalence of motor skill impairment among West Coast grade R children by conducting a cross-sectional descriptive prevalence study using multistage cluster sampling.
2. To identify and describe interventions for improving motor skills in pre-school children with motor skill impairment by using a scoping review methodology.
3. To design an intervention programme for pre-school children with motor skills impairment enrolled in schools in a low socio-economic area by using the Delphi technique.
4. To draft a protocol for an exploratory RCT to determine the preliminary effect of a motor skill programme on the motor and academic skills of grade R learners, in preparation for further evaluations of feasibility and effectiveness.

Methodology

A complex intervention development model (Craig et al., 2019) was adopted for this study. This model is used in healthcare and rehabilitation to develop interventions that have several interacting components and unique specific challenges, in addition to the usual practical and methodology difficulties (Medical Research Council, 2006). Complex intervention development is a systematic, albeit dynamic process. Its fluid, adaptable and progressive approach also considers future evaluation and implementation (Duggleby et al., 2013). In their updated guidelines for the Medical Research Council (MRC), Skivington et al. (2018) describe the elements of complex intervention's development phase as the *identification of an evidence base*; the *identification or development of theory* and *modelling of the process and outcomes* (Skivington et al., 2018). This has helped bridge the gap between the theoretical guidelines and implementation. The developmental stage is followed by a *pilot/feasibility stage, evaluation stage and implementation stage*.

The complex intervention development model has been used successfully in a study by Missiuna, Pollock, Campbell et al. (2012), describing the development of the Partnering for Change model (P4C) (a school-based intervention for children with DCD). This study used a framework for complex intervention development (Campbell et al., 2000) and was followed up by a feasibility study where the MRC framework (Craig et al., 2008) was used to assess the feasibility of the P4C model in elementary schools in the UK (Missiuna, Pollock, Campbell et al., 2012). The P4C model was found to be feasible, while issues and challenges were identified to be addressed in further studies. A recent study investigated the perception

of therapists of their relationships with families in the P4C intervention (Kennedy et al., 2019) and demonstrates the fluidity and continuation that occurs in complex interventions. In that study, factors that affect the therapist–family relationship were identified through focus groups and the study led to recommendations to improve opportunities for collaboration which would impact positively on the programme.

The complex intervention development model, as described by Craig et al. (2019), was the preferred model for this study. Firstly, because the envisaged intervention was likely to have interacting components, each with unique challenges, and would be dependent on the behaviours of those delivering and receiving the intervention. Secondly, there was going to be a need to tailor the intervention to different contexts or settings, depending on the outcomes of the informative studies (Craig et al., 2019). For the development of a motor skill intervention in the context of a low socio-economic rural setting, several unique challenges were anticipated. Motor skills impairment includes a range of presentations and diagnoses among the target group. In addition, a multidisciplinary view was envisaged involving therapists, teachers and other developmental or motor skills specialists. The methodology of this study focuses on the development phase and the preparation of the pilot phase of complex intervention to design a tailor-made motor skill intervention programme. The intervention targets the specific needs of children in a community in a low socio-economic area with limited resources. Further evaluation and implementation are considered as continued development of the intervention in the future.

Considering the challenges faced in developing such a complex intervention, quantitative and qualitative methods were used for this study (Cathain et al., 2019). Findings are integrated and interpreted as the stages progress through an explanatory sequential mixed methods design (Fitzmaurice & Laird, 2015). In the study as a whole, and through the stages of complex intervention development, a positivist perspective considered statistical and empirical quantitative data which contributed to the theory and knowledge base considered for the development of the intervention. Qualitative data was used to support and explain quantitative data through a realist perspective (Khanna, 2018). This perspective meant that quantitative data was considered with a view on influencing and confounding factors identified qualitatively.

The practical application of the complex intervention model and future considerations are illustrated in Figure 1.1

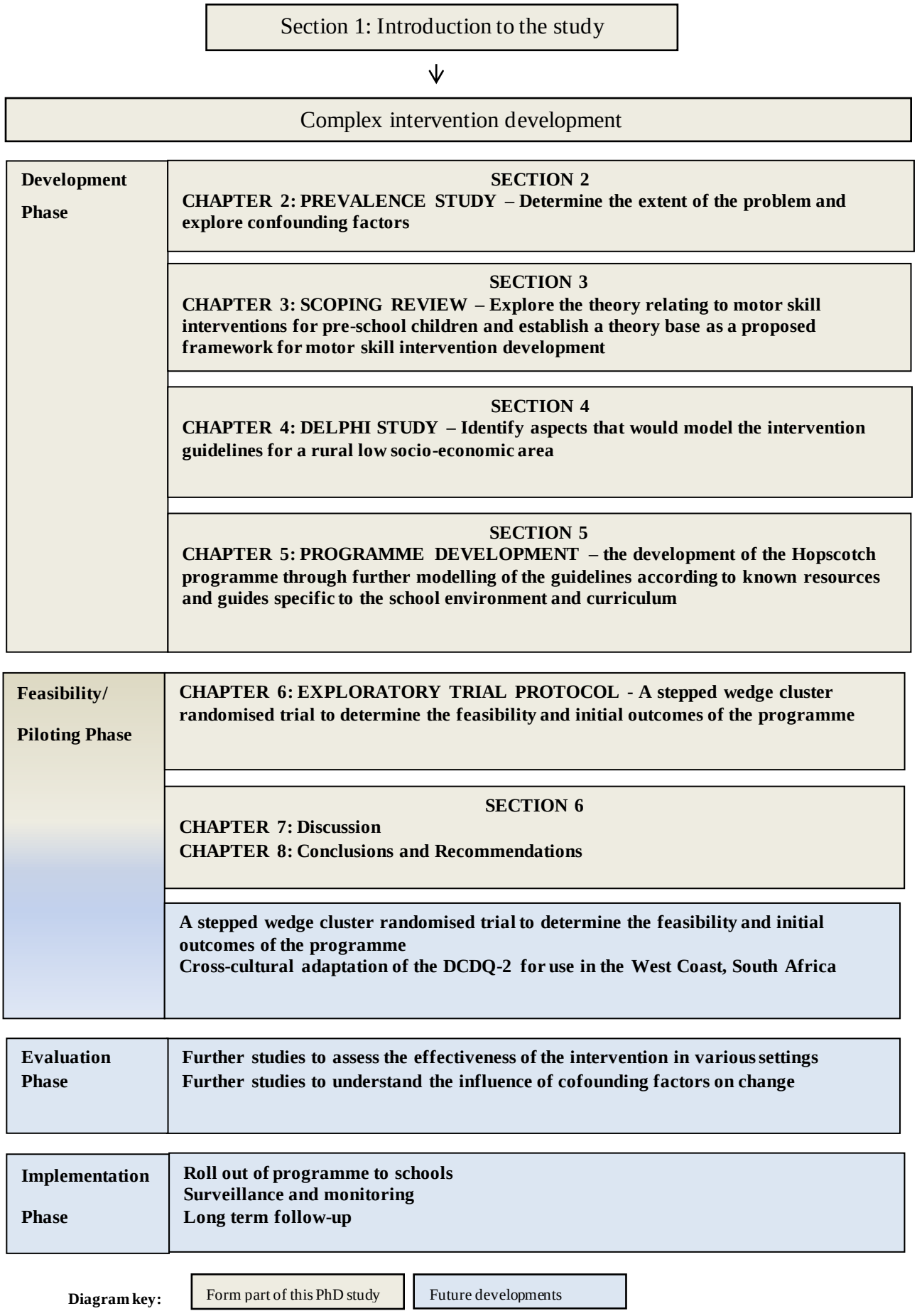

Figure 1.1: Diagram to illustrate the structure of the dissertation including the complex intervention development model

In this study, the identification of an evidence base as the first step of complex intervention development first took place through means of a prevalence study (Chapter 2) to determine the extent of motor skill difficulties among grade R learners on the West Coast of South Africa. This was a quantitative study utilising a cross-sectional descriptive design, with multistage cluster sampling. The MABC-2 (Henderson et al., 2007) was used to test grade R children (n = 138) in six schools. A descriptive analysis of the scores of the MABC-2 was carried out. Parametric tests (Pearson chi^2 tests) were used to determine the effect of the confounding factors on motor skill impairment including gender, playgrounds, fee vs no-fee schools, and low body weight and short stature. A non-parametric test was used to measure the effect of confounders such as weight and height on motor skills. A significance level was set with $p < 0.05$. The study confirmed a high prevalence of motor skill impairment at 14.5%. The findings of this study concurred with that from similar studies conducted in other low socio-economic status areas (Valentini et al., 2015), and confirm the association between poorer communities and higher incidence of motor skill impairment seen on the West Coast.

Existing literature on motor skill interventions for pre-school children was reviewed by means of a scoping review, which contributed to further understand the evidence base on which to ground intervention development. The scoping review (section 3, Chapter 3) aimed to identify interventions for motor skill impairment in pre-school children. The PRISMA-SCR guidelines (Tricco et al., 2018), and the six stages of planning a scoping review (Levac et al., 2010), were followed. Forty-five records were identified to include in the scoping review through structured database searches and screening of records according to inclusion and exclusion criteria. Data were captured on custom-designed MS Excel spreadsheets and analysed quantitatively by either calculating the total, percentage, mean, median or range according to data sets. Additional essential information was analysed qualitatively and categorised to create a summary of evidence-based recommendations. The scoping review echoed other systematic and scoping reviews' findings regarding the heterogeneity of approaches and treatment methods in the field of motor skill intervention (Camden et al., 2015; Hillier, 2007; Levac et al., 2009; Logan et al., 2012; Riethmuller et al., 2009). A theoretical model was developed to facilitate planning of motor skills interventions in any context, and was the final product of the scoping review.

Next, a follow-up Delphi study identified specific requirements for an intervention suited to grade R learners on the West Coast, and assisted in the modelling of the intervention. The three-round Delphi study (section 4, Chapter 4) relied on expert agreement to guide the

development of a low SES community-specific intervention for pre-school children with motor skills impairment. The guidelines for Conducting and REporting DElphi Studies (CREDES) (Jünger et al., 2017) and further guidelines by Day and Bobeva (2005) informed the Delphi process. The criteria for dropping items in each Delphi round was that consensus (75% or mean >4) was reached. Information was captured onto a custom MS Excel worksheet and analysed quantitatively by calculating the level of agreement by the percentage or mean. Open-ended comments from participants were analysed qualitatively by listing, categorising and grading comments. Delphi study participants were guided by the results from the scoping review, but had to apply their own expertise and experience to decide on a model to best fit the unique needs and circumstances of the specific named area. Ikiugu's model of eclecticism (Ikiugu & Smallfield, 2011) was adopted to utilise the results from the prevalence study, scoping review and Delphi study to develop the theoretical practice model for the motor skill intervention programme, specifically developed for grade R children in the West Coast region.

Considering all the data, "a fit-for-West Coast" motor skill intervention programme, Hopscotch, was developed (section 5, Chapter 5), following the template for intervention description and replication (TiDier checklist) (Hoffmann et al., 2014). For this programme, an activity-based body-function approach was adopted using visual-perceptual motor, sensory integration and task-specific training principles. The Hopscotch programme is a comprehensive motor skill intervention with a compelling evidence base. The underlying features of affordability, integration with the current school programme and task-shifting to grade R teachers, aim to make the intervention feasible and sustainable. The fluidity in the development of the programme structure and eclectic theoretical approach that underpins the programme is described as it developed through the stages of the study (Table 5.1, Chapter 5).

The final phase is a draft proposal for an exploratory trial to determine preliminary effect of the programme in preparation for future feasibility studies and RCTs. The exploratory trial is a quantitative study, using a cluster randomised stepped wedge trial design, and will be conducted on the West Coast. Following ethics approval, the eight schools selected will be invited to participate and will randomly be assigned to an experimental or control group. Scores of the MABC-2 (Henderson et al., 2007) at baseline will be used to determine which learners will be included in the intervention groups. Only children who scores below the 15th

percentile on the total score or manual dexterity score will participate in the intervention. The MABC-2 will measure motor skill proficiency as primary outcome measure, with scores from the DCDQ-2 as supportive comparative data. The Kaufman Test of Educational Achievement (KTEA-3-Brief) (Kaufman, 2015) will be administered to measure academic progress as secondary outcome measure. Facilitators of the programme will be asked to keep a diary and responses will be analysed qualitatively using inductive thematic analysis (Janssens et al., 2018).

This dissertation describes the first developmental stage of the complex intervention model and initiates the planning of the second phase through a protocol for an exploratory trial of the Hopscotch programme. The protocol was developed in preparation for future post-doctoral evaluation and implementation in stages three and four of complex intervention development. Based on the future findings of the exploratory trial, preliminary recommendations will be made to the education department. It is envisaged that further long-term monitoring will assist in ongoing updates and improvement of the intervention.

Structure of the Dissertation

The dissertation follows the Hybrid (3) dissertation format of the Faculty of Medicine and Health Sciences, Stellenbosch University. This format requires the inclusion of at least two published articles or articles accepted for publication in a peer-reviewed journal of which the PhD student is the first author. These articles form the dissertation, together with chapters of introduction, discussion and conclusion. In addition, at least two more articles, which are ready for submission, should be included (University of Stellenbosch, 2019).

This dissertation has six sections with eight chapters. Section 1, Chapter 1 introduces the study and provides the contextual background. Section 2, Chapter 2 presents the published prevalence study. Section 3, Chapter 3 presents the published scoping review. Section 4, Chapter 4 presents the publication-ready Delphi study. Section 5, Chapter 5 describes the integration of the findings of the previous three studies to develop the final version of the Hopscotch programme. Then Chapter 6 presents the publication-ready exploratory RCT protocol. Section 6 includes a discussion of the findings and limitations of the research (Chapter 7), and conclusions (Chapter 8).

This study makes a unique contribution to the field of motor skill impairment intervention for children living in poor SES or low-resourced settings by proposing a resource effective, yet

evidence-based multidisciplinary motor skill programme. Figure 1.1 displays the outlay of the structure of the dissertation. The timeline of the study is available in Appendix 1: Research timeline. The initial ethics clearance letter from the HREC is available in Appendix 2: HREC PHD initial approval .

SECTION 2

THE PREVALENCE OF MOTOR SKILL IMPAIRMENT AMONG PRE-SCHOOL CHILDREN ON THE WEST COAST OF SOUTH AFRICA

Chapter 2

Introduction

In the absence of prevalence data available, this was a preparatory study, conducted to determine the prevalence of motor skill impairment among grade R children on the West Coast of South Africa. Although international data is available regarding conditions associated with motor skill impairment in countries with a similar socio-economic status (Camden et al., 2015), the West Coast of South Africa has unique challenges. On the one hand, there is a high incidence and prevalence of diseases causing some degree of motor skill difficulties (Ferguson & Jelsma, 2009; Olivier et al., 2013; Potterton & Eales, 2001), while the lack of prevalence data on conditions such as DCD and ASD in South Africa may indicate underdiagnoses and a lack of awareness of these conditions. A better understanding of the extent of the problem in a community would assist in understanding of challenges and requirements when planning interventions.

Due to the high level of functional presentation of motor skill impairment (Lingam et al., 2009), the prevalence study was approached and presented from an educational viewpoint. The *South African Journal of Education* (impact factor = 0.783) (SA Journal of Education, 2021) was the authors' first choice for publication. An educational focus would help increase awareness in schools of motor impairment among young children, the impact it may have on school-readiness and the importance of motor skill development with regards to academic abilities. As the study was population-specific, and due to the lack of prevalence data in South Africa, a South African journal was preferred.

The prevalence study was conducted by the primary researcher, with assistance of five final year occupational therapy students in two of the six participating schools. These schools were selected through multi-stage cluster sampling and all grade R children were invited to participate. The first-hand experience of, for example, observing accessibility of rural areas, school structures and surrounding community areas provided the researcher with an increased understanding of the needs and challenges of children and communities on the West Coast. An occupational therapy, or occupational engagement view here assisted the researcher to consider the environment as an integral part of the motor skill challenges experienced by grade R children in the region (Hammell & Iwama, 2012). In addition, the study added valuable information on variables associated with higher impairment scores through, e.g., the

presence or lack of playground facilities, as well as demographic data such as the learners' height and weight and SES of a community (fee vs no-fee schools). This information contributed to the follow-up stages of the intervention development. It was added to the background information provided to Delphi study participants as guidance in decision-making and recommendations for the development of an intervention for the West Coast area. The information also guided the researcher's reasoning and considerations through the programme development phase.

The researcher had the opportunity to provide initial guidance in the form of short feedback reports to parents with advice to teachers and parents where indicated. All grade R children in participating schools received an exercise book as well as an easy-grasp triangular pencil. Hand-outs about pencil grip, working posture and school readiness skills were pasted in the front of the books. The project was funded by the Faculty of Medicine and Health Science's (FMHS) Early Career Researcher Development Grant (Stellenbosch University).

Documents related to the planning and implementation of the prevalence study can be viewed as follow:

- HREC ethics approval letter: Appendix 3: HREC approval Prevalence study
- HREC ethics approval letter (minor adaptations): Appendix 4: HREC approval minor adaptations for Prevalence study
- WCED approval letter: Appendix 5: WCED letter of approval
- Information and consent letter (English): Appendix 6: Information and consent letter for prevalence study (English)
- Information and consent letter (Afrikaans): Appendix 7: Information and Consent letter Prevalence study (Afrikaans)
- Parent checklist (English): Appendix 8: Parent checklist (English)
- Parent checklist (Afrikaans): Appendix 9: Parent checklist (Afrikaans)
- Photos of the MAB-2 being carried out in schools as well as the different playgrounds observed: Appendix 10: Prevalence study images

- Example of a hand-out provided to all grade R pupils: Appendix 11: Prevalence study hand-outs
- Example of a feedback report: Appendix 12: Example of a feedback report during the prevalence study
- Example of advice and guidance provided for individual children: Appendix 13: Example of advice provided to parents
- Summarised feedback report to WCED: Appendix 14: Summarised report to WCED

The MS Excel worksheet with prevalence data can be accessed at:

https://stellenbosch-my.sharepoint.com/personal/17390885_sun_ac_za/_layouts/15/Doc.aspx?OR=teams&action=edit&sourcedoc={1306F5C0-C5FD-4EC6-AF8F-A15BB78B741B}

The published paper can be viewed at:
https://www.ajol.info/index.php/saje/article/view/194262

Published paper 1: Prevalence of motor skill impairment among Grade R learners in the West Coast District of South Africa

Art. #1667, 8 pages, https://doi.org/10.15700/saje.v40n1a1667

Prevalence of motor skill impairment among Grade R learners in the West Coast District of South Africa

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A high prevalence of medical conditions affects the typical motor development of learners in the West Coast District of South Africa. Given the strong correlation between motor skill performance and academic achievement, this study aimed to determine the prevalence of motor skill impairment among Grade R learners (5–7-year olds) enrolled in public schools in the area. Multistage cluster sampling was used to identify 6 schools from which all Grade R learners were invited to participate. Following ethical approval, 138 learners' gross and fine motor skills were assessed using the Movement Assessment Battery for Children 2nd edition (M-ABC2). Results indicate that the prevalence of significant motor skill impairment in this region was high at **14.5%**, and that the prevalence of children with manual dexterity difficulties was very high, at **24.6%** (i.e. scores below the 15th percentile of the M-ABC2) when compared to global statistics, yet comparable to countries with a similar socio-economic structure. The prevalence of children with balance difficulties was **18.1%**, while the prevalence of children with difficulties in aiming and catching was low at **4.3%**. Pearson's correlation indicates that gender (male), a lack of playground equipment and low weight/height are factors associated with learners' poor manual dexterity, while poor manual dexterity and balance skills were associated with learners attending no-fee schools. The study confirms that motor skill difficulties are a significant problem in this region and calls for further research to address the problem.

Keywords: academic progress; Grade R learners; manual dexterity; motor impairment; motor skills; prevalence

Introduction

There is a strong correlation between motor skill difficulties and academic achievement (Geertsen, Thomas, Larsen, Dahn, Andersen, Krause-Jensen, Korup, Nielsen, Wienecke, Ritz, Krustrup & Lundbye-Jensen, 2016). Studies have shown that fine motor skills together with general knowledge and executive functioning i.e. attention shifting, working memory, and inhibitory control; are strong academic predictors (Grissmer, Grimm, Aiyer, Murrah & Steele, 2010; Pienaar, Barhorst & Twisk, 2014). The level of a pre-school child's fine motor skill competence can also predict the level of progress s/he is likely to achieve over a six-month period (Cameron, Brock, Murrah, Bell, Worzalla, Grissmer & Morrison, 2012; Carlson, Rowe & Curby, 2013).

In South Africa, the prevalence of health conditions associated with motor skill impairment such as Human Immunodeficiency Virus (HIV), Acquired Immune Deficiency Syndrome (AIDS) (Avert, 2012) and Fetal Alcohol Syndrome (FAS) (Olivier, Curfs & Viljoen, 2016) is high. In addition, environmental factors such as high rates of crime and food insecurity may contribute to decreased levels of physical activity and motor proficiency among young children (Ghosh, Ghosh, Dutta Chowdhury, Wrotniak & Chandra, 2016). Low socio-economic status is a consistent predictor of poor motor skills as is evident in studies in countries with a similar, newly advanced economic development status as in South Africa. These include Brazil (Valentini, Clark & Whitall, 2015), China (Jin, Gu, Qin, Bai & Ma, 2015), and India (Girish, Raja & Kamath, 2016). Venter and Bham (2003) propose that this may account, in part, for the low levels of reading and mathematics literacy observed in some parts of South Africa. These factors are all predictors of high prevalence of motor skill impairment, however statistical evidence is lacking.

While motor skill impairments are often evident before children start school, these do not spontaneously improve without therapeutic intervention (Hillier, 2007). Early identification of, and intervention for children with gross and fine motor skill impairment is therefore important to facilitate and maximize academic performance (Erasmus, Janse van Rensburg, Pienaar & Ellis, 2016; Grissmer et al., 2010; Pienaar et al., 2014).

In our experience, teachers, therapists and healthcare professionals working in the West Coast District, a peri-urban/rural setting, face daily obstacles and restraints. Challenges faced by therapists in the region include limited staff, transport, and budgets. These challenges are also found elsewhere in South Africa (Bateman, 2012) and have been reported globally. For instance, in China (Prakash, Hariohm & Balaganapathy, 2014) and British Columbia (Roots, Brown, Bainbridge & Li, 2014) rehabilitation therapists echo accessibility and staff and resource shortages as barriers to service delivery. Limitations in resources are, however, altering therapists' perceptions of health and their roles as therapists, as the importance of community involvement is emphasised (Roots et al., 2014).

We believe that an urgent need exists for the improvement of health and academic outcomes among pre-school children living in the West Coast District of South Africa. However, before a school- or community-based intervention for pre-schoolers living in this region can be developed, it is crucial to know how prevalent the condition is. This knowledge would allow practitioners to target interventions for Grade R (pre-school) learners where they are needed most. At the time of our study no reliable prevalence data for motor skill impairment among pre-school children in this area or similar settings anywhere in South Africa existed. International prevalence data focusses predominantly on Developmental Coordination Disorder (DCD) and vary widely due to the diversity of populations, sampling, and outcome measures used. The aim of this study was, therefore, to describe the prevalence and level of motor impairment among pre-school children aged 5 to 6 years old living in the West Coast District of the Western Cape. Possible influencing factors were investigated as a secondary aim.

Conceptual Framework

Literacy is a significant problem on the West Coast of South Africa, with less than one quarter of adults over 20 years completing high school and one in five adults unemployed (Western Cape Government, 2016). In South Africa children struggle with academic achievement as early as Grade 1 (Venter & Bham, 2003). In fact, 52% of learners repeat a grade before Grade 10 (Grossen, Grobler & Lacante, 2017). One reason for the academic underachievement could be motor skill difficulties resulting from conditions with a high incidence in South Africa such as HIV (Rollins, Dedicoat, Danaviah, Page, Bishop, Kleinschmidt, Coovadia & Cassol, 2002) and FAS (Olivier et al., 2016). Research indicates that poor motor skills influence academic performance and a study from Finland (Haapala, Poikkeus, Tompuri, Kukkonen-Harjula, Leppänen, Lindi & Lakka, 2014) found that the 33% of children with the lowest level of motor performance had dramatically lower mathematics and reading scores across Grades 1 to 3 compared to children in the rest of the sample (n = 174, mean age = 7.7 years). Another study conducted among 423 older Danish children (mean age = 9.29 years) found significant relationships between fine and gross motor skills and cognitive abilities such as mathematics and reading (with $p < 0.001$) (Geertsen et al., 2016). A study in North America found that fine motor skills predicted better performance in sound awareness, picture vocabulary, passage comprehension, letter-word identification, and reading (Cameron et al., 2012). A study in Canada similarly found a relationship between fine motor skills and receptive language skills (Pagani, Fitzpatrick, Archambault & Janosz, 2010). This study also found a relationship between fine motor skills and classroom participation. In the longer term, fine motor skills in kindergarten predicted reading ability in the second grade, mathematics, and general achievement. All the above studies highlight the importance of developing fine motor skills for a wide range of competencies, beyond the ability to draw and write, required for primary school learning.

Improving motor skills can enhance academic skills. Sherry and Draper (2013) advocate the use of gross motor interventions to address school readiness deficits. The authors made these recommendations following their experience in running a community-based programme (Little Champs) to help develop motor and cognitive skills in pre-school children from disadvantaged settings in South Africa (Draper, Achmat, Forbes & Lambert, 2012). Their findings suggest that significant progress occurred even with limited exposure to a low impact programme.

Few studies report on the prevalence of motor skill impairment among pre-school children, and those that do include this cohort, focus on children with specific health conditions. One Iranian study investigated the prevalence of motor development disorders among infants between four and 18 months and reported a normative prevalence of 3% (Soleimani, Vameghi, Biglarian & Rahgozar, 2014). Hillier (2007), in a systematic review that investigated the efficacy of interventions for children with Developmental Coordination Disorder (DCD), states that the prevalence of DCD is between 6 and 13% for school-aged children (Hillier, 2007). A more recent scoping review reported that the prevalence of DCD is consistently reported as 5 to 6% for all children (Camden, Wilson, Kirby, Sugden & Missiuna, 2015). It is also evident that the prevalence of motor impairment in developing countries is much higher than in developed countries/settings. In a study of disadvantaged Brazilian children (4 to 10 years), it was found that 18% of these children presented with DCD, with a further 15% being at risk of having DCD (Valentini et al., 2015). Another study among pre-school children (3 to 6 years) in the Jiangsu province of China, found that 6% of children met the criteria for DCD, with a further 15.6% with probable DCD (Jin et al., 2015). Among pre-term and low birth weight infants who do not develop cerebral palsy, the prevalence of motor impairment is very high and varies between 40.5% (with mild impairment) to 19% (with moderate impairment) (Williams, Lee & Anderson, 2010). Motor impairment among HIV-infected preschool children in the Cape Town area is reported to be even higher and was reported at 66% (Ferguson & Jelsma, 2009).

Other studies do not report motor impairment, but instead focus on the mastery of fundamental movement skills among children in mainstream

schooling. One such study conducted in Australia reported a low level of mastery of fundamental movement skills among Australian children (Hardy, Reinten-Reynolds, Espinel, Zask & Okely, 2012). A study from South Africa (Draper et al., 2012) showed that 15% (n = 100) of children from disadvantaged backgrounds scored very low in fine motor skills, while 8% scored very low in gross motor skill performance tests.

Young learners in South Africa, many from disadvantaged backgrounds, are often faced with complex medical and/or developmental conditions that effect their motor skills and ability to learn. Currently no prevalence data is available to identify the areas where the greatest need exists. Such reliable data is the first step required for intervention.

Method

Study Design

A cross-sectional descriptive study design was used to determine the prevalence of significant motor skill difficulties in Grade R learners in mainstream government schools of the West Coast.

Sampling

Multistage cluster sampling was used to identify six schools according to municipal areas, location (urban main places, urban areas and rural areas) as well as free/paying schools. Children with specific neurological conditions such as cerebral palsy, or muscular pathology such as muscular dystrophy, and children with physical disabilities or significant physical injuries were excluded from the study as these children have known motor dysfunction and are cared for in the public health care system. All children with other diagnoses such as DCD, attention deficit hyper-activity disorder (ADHD), attention deficit disorder (ADD), FAS, HIV/AIDS, etc., not commonly associated with a physical disability, were allowed to participate. Children receiving physiotherapy or occupational therapy were included in the study only if they had not been assessed using the M-ABC2 within the six months prior to the study, as this could affect the validity of the test. One hundred and thirty-nine Grade R learners (age 5 to 7), of which 66 girls and 72 boys, were included in the study. Only one child was later excluded from the study due to being absent on the day of testing.

Instruments and Procedure

The M-ABC2 (Henderson, Sugden & Barnett, 2007) was used to assess participants' motor skills. This tool provides objective quantitative data on motor skills performance. The performance test is designed to be administrated individually and requires children to perform a series of eight motor tasks according to their specific age groups in a standard way. These tasks are categorised as manual dexterity, balance, and aiming and catching. The test provides clear criteria to indicate significant motor skill delay and has been standardised for children without muscular or neurological pathology (Henderson et al., 2007). Raw scores are converted to standard scores and percentiles for individual items. Total scores can also be calculated. The total test score percentiles indicate levels of motor impairment at intervals of percentile.

As equipment for the test is standard and included, no additional equipment is needed. A qualified occupational therapist administered the assessments at four schools. Five occupational therapy students in their fourth year of study completed assessments at two schools as part of their research project.

Parents were asked to complete a simple questionnaire to supply additional information regarding their children's activities, therapies attended, and number of years in Grade R. All children were weighed and measured, and gender was recorded as additional anthropometric information.

Analysis

A descriptive analysis of the categories of the total percentages and subtests of the M-ABC2 were carried out. The categories of manual dexterity, ball skills and balance were analysed separately as well as for the total score. The guidelines as described in the M-ABC2 were used where a score below the 5th percentile indicates definite significant motor skill difficulty, a score between the 5th and 15th percentile indicates a risk of motor difficulties and a score above the 15th percentile indicates no risk of motor skill difficulties (Henderson et al., 2007). For the purpose of this study, the prevalence figures were measured for all scores below the 15th percentile in accordance with other international prevalence studies (Salie, 2009; Venetsanou, Kambas & Giannakidou, 2015).

Parametric tests (Pearson X^2 tests) were used to determine the effect of the following factors on motor impairment: gender, type of school (no-fee vs paying schools), and extent of playground available. A non-parametric test (Kruskal-Wallis) was used to measure the effect of weight and height on motor skills. Skewness statistics and its standard error indicated that weight was not normally distributed even though height was. A significance level was set at $p < 0.05$.

Results

Seventy-two boys and 66 girls (n = 138) participated in this study. The average age, weight and height of the children, with standard deviations, are shown in Table 1 and the data is noted according to gender, type of school (no-fee vs paying), and extent of the playground.

Table 1 Descriptive data for enrolled sample

	N	Age (years) *M*±*SD*	Height (cm) *M*±*SD*	Weight (kg) *Mdn* (range)
Male	72	6.6±0.38	115±6.26	20 (13–38)
Female	66	5.9±0.53	112±6.65	19 (10–38)
No-fee	69	5.9±0.51	112±6.17	18 (10–38)
Paying	69	5.11±0.47	115±6.53	22 (15–38)
Extensive playground	41	5.8±0.55	114±6.82	23 (16–38)
No/limited playground	97	5.9±0.41	113±6.31	19 (10–38)
Total	138	5.11±0.47	113±6.66	20 (10–38)

Prevalence of Motor Impairment

The total score and subtest scores for manual dexterity, aiming and catching, and balance, as determined using the M-ABC2, are shown in Table 2. Across all three sub-tests, the proportion of children falling below the 5th percentile was higher than the proportion of children at risk (between 5th and 15th percentile). The findings suggest a high prevalence of manual dexterity and balance difficulties.

Table 2 M-ABC2 scores

	< 5th percentile	5th–15th percentile	< 15th percentile
Total score	8.7%	5.8%	14.5%
Manual dexterity	14.5%	10.1%	24.6%
Aiming and catching	2.2%	2.2%	4.3%
Balance	12.3%	5.8%	18.1%

Factors Associated with Motor Impairment

Gender

Pearson X^2 tests revealed that gender was associated with manual dexterity ($p < 0.05$) (Table 3), with boys significantly more likely to develop manual dexterity difficulties than girls. Gender was not associated with the total score ($p > 0.05$), aiming and catching, or balance.

Table 3 Influence of gender on the standard scores, manual dexterity, aiming and catching, and balance

		< 5th percentile	5th–15th percentile	> 15th percentile	*p*
Total score	Male	9.7%	2.8%	87.5%	0.27
	Female	7.6%	9.1%	83.3%	
Manual dexterity	Male	13.9%	16.7%	69.4%	0.029
	Female	15.2%	3.0%	81.8%	
Aiming and catching	Male	2.8%	1.4%	95.8%	0.712
	Female	1.5%	3.0%	95.5%	
Balance	Male	13.9%	6.9%	79.2%	0.677
	Female	10.6%	4.5%	84.8%	

No-fee vs paying schools

No-fee schools were associated with poor manual dexterity ($p < 0.05$) as well as balance difficulties. As is clear from Table 4, type of school was not associated with the total score or aiming and catching.

Table 4 Influence of the type of school on the total scores, manual dexterity, aiming and catching, and balance

		< 5th percentile	5th–15th percentile	> 15th percentile	*p*
Total score	No fee	13%	7.2%	79.7%	0.132
	Fee	4.3%	4.3%	91.3%	
Manual dexterity	No fee	21%	13%	65.2%	0.018
	Fee	7.2%	7.2%	85.5%	
Aiming and catching	No fee	1.4%	0%	98.6%	0.178
	Fee	2.9%	4.3%	92.8%	
Balance	No fee	18.8%	2.9%	78.3%	0.03
	Fee	5.8%	8.7%	85.5%	

Playgrounds

For the purpose of this study, schools were described as having an extensive playground (multiple playground equipment) or a very limited/no playground (one piece of equipment, e.g., a swing/climbing frame or just a level play area). Schools with a limited or no playground were associated with poor manual dexterity ($p < 0.05$). The extent of the playgrounds was not associated with the total score, aiming and catching, or balance skills, as described in Table 5.

Table 5 Influence of playground facilities on the total score, manual dexterity, aiming and catching, and balance

		< 5th percentile	5th–15th percentile	> 15th percentile	*p*
Total score	Extensive playground	2.4%	4.9%	92.7%	0.216
	Limited playground	11.3%	6.2%	82.5%	
Manual dexterity	Extensive playground	4.9%	2.4%	92.7%	0.009
	Limited playground	18.6%	13.4%	68.0%	
Aiming and catching	Extensive playground	2.4%	4.9%	92.7%	0.362
	Limited playground	2.1%	1.0%	96.9%	
Balance	Extensive playground	7.3%	9.8%	82.9%	0.25
	Limited playground	14.4%	4.1%	81.4%	

Weight and height

Low body mass (weight) as well as shorter posture (height) were significantly associated with poor manual dexterity. Neither weight nor height was associated with the total score, aiming and catching, or balance (see Table 6).

Table 6 Influence of weight and height on the total score and individual aspects of manual dexterity, aiming and catching, and balance

	Influence of weight (*p* value)	Influence of height (*p* value)
Total score	0.118	0.220
Manual dexterity	0.002	0.005
Aiming and catching	0.278	0.372
Balance	0.954	0.971

Discussion

A higher prevalence of motor skill impairment (14.5%) among children aged 5 to 7 years living on the West Coast of South Africa was found when compared to international figures, where the prevalence of DCD is reported to be between 5 and 6% (Camden et al., 2015). These findings are comparable to countries with similar economic development (Jin et al., 2015; Schultz, 1999; Valentini et al., 2015), and contributes to the evidence that suggests that children living in areas of lower socio-economic status are more likely to present with motor skill difficulties than those from higher socio-economic settings. This also suggests that these areas have a greater need for therapeutic interventions. The lack of therapy resources in these poor-resourced settings means that children with motor difficulties may not be identified timeously and may never receive the therapeutic input they need to improve their skills. Consequently, many of these children may be disadvantaged and not fully ready to face the challenges of the mainstream curriculum. This places them at a disadvantage to progress, even before they start school.

Particularly alarming is our finding that approximately one quarter (24.6%) of participants in this study scored below international norms for fine motor skills, also known as manual dexterity difficulties. Fine motor skills difficulties are strongly associated with auditory comprehension and levels of attention (Jacobs, Miller & Tirella, 2010), as well as school readiness (Cameron et al., 2012). This means that at least a quarter of children living on the West Coast are potentially not ready to start formal schooling. The provision of these statistics may help to create awareness of the significance of the problem.

Current literature often focuses on the relationship between motor skills and obesity. In a large population-based study of the relationship between obesity and motor skills in the United States of America, Castetbon and Andreyeva (2012) found no difference in coordination or fine motor skills among children aged 5 to 6 years (n = 5,100). Only jumping and hopping (gross motor skills) appeared to be affected by obesity (Castetbon & Andreyeva, 2012). In contrast, our study highlights the negative effect that low body mass and height can have on the development of motor skills, particularly fine motor skills. Despite no-fee schools all having a feeding programme in place where children receive one to two meals daily, some children were still underweight and shorter than their peers from less poorer settings. The importance of a healthy diet and lifestyle should be regarded as a priority for pre-school children, not only to combat obesity, but also to assist in developing a healthy body-mass index (BMI) for children who are possibly malnourished. Children with a low BMI should be monitored and screened as priority for possible motor skill difficulties.

Schools in the public sector are considered no-fee (free) or not, according to the parents' income, unemployment rate, and levels of education. Results indicate that learners in no-fee schools are more prone to fine motor difficulties. No-fee schools also had no or very limited playground equipment, for example, one small jungle gym or climbing frame, while all the fee-paying schools had more extensive playgrounds. This study supports the notion that access to playgrounds at school contributes significantly to children's development of fine motor skills. It was, however, interesting that learners with no or very limited access to playgrounds had developed good ball skills – in most cases better than those of learners with access

to playgrounds. This may be because ball play is a relatively cheap and easily accessible option of play where not many play facilities are available. The size and quality of playgrounds were also highlighted as a strong influencing factors in children's motivation to take part in physical play (Delidou, Matsouka & Nikolaidis, 2016). This emphasises the importance of considering environmental factors, including the role parents and the community in supporting and promoting play in young children.

One limitation of this study is that it focused on mainstream government schools only. How this will compare to prevalence in private schools and/or special schools is yet to be determined. The results of this prevalence study however confirm the significant challenges that pre-school children face with regard to motor skill development and subsequent school readiness.

Conclusion

A high prevalence of motor skill impairment, fine motor difficulties in particular, among Grade R learners in the West Coast District of South Africa indicates a need for input to address the problem. It appears from this study that children in no-fee schools were more prone to lower body mass and height, and lacked playground opportunities. The results show that both these factors were significant indicators of fine motor difficulties. This study introduces several unanswered questions regarding community involvement, socio-economic issues, nutrition, and the effect of playground equipment on the development of learners' motor skills. The study further highlights the need to develop an affordable therapeutic input method to help improve motor skills in Grade R learners to help prepare them for Grade 1 and a better educational future. Further research in these areas is implied, which should provide valuable information concerning ways or methods for addressing motor skill difficulties in many young children, not only in South Africa, but also in countries with similar socio-economic structures.

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Author's Contributions

Janke van der Walt conceptualised and designed the study, collected data (together with occupational therapy [OT] students) and carried out the initial analyses, drafted the initial manuscript and reviewed and revised the manuscript. Nicola Plastow and Marianne Unger coordinated and supervised the study including data collection, critical review of the manuscript for important intellectual content and the review and revision of the manuscript. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

Notes

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Conclusion and Implications

The prevalence study found that there is a high prevalence of motor skill impairment (14.5%) among grade R children in government schools on the West Coast of South Africa., The prevalence of fine motor skill difficulties was very high at 24.6%. This suggests that many pre-school children in the region need therapeutic intervention to improve motor skills in preparation for school and academic readiness. Socio-economic factors and environmental factors such as playground opportunities were found to have a significant effect on fine motor skill proficiency.

The implications of the prevalence study is that there are many pre-school children on the West Coast who do not have access to much needed therapy services. There is a need for a sustainable high quality motor skill intervention that is cost and resource effective. This would mean utilising existing resources in schools, channelling known therapy services in the area and creating new play-opportunities for motor skill learning through community involvement. However, the next step would be to first gather an evidence and theory base to develop the complex intervention that is needed to address the need confirmed through this prevalence study (Camden et al., 2015; Hillier, 2007; Riethmuller et al., 2009; Ward et al., 2017).

SECTION 3

SCOPING REVIEW: MOTOR SKILL INTERVENTION FOR PRE-SCHOOL CHILDREN

Chapter 3

Introduction

The scoping review presented in this chapter examines studies that focus on motor skill intervention for pre-school children. A scoping review rather than a systematic review was the preferred methodology due to the wide scope of the review (McKinstry et al., 2014; Munn et al., 2018; Pham et al., 2014). A wide range of diagnoses associated with motor skill impairment was included because of the presumed high incidence of undiagnosed or unspecified motor skill impairments in a low socio-economic area, such as the West Coast of South Africa (Ferguson & Jelsma, 2009; Olivier et al., 2013). Consequently, all possible types of intervention, intervention settings and disciplines involved in treating motor skill impairment were considered.

The aim of the scoping review was not to critically appraise the evidence, as would be the case in a systematic review (Moher et al., 2009), but rather to map out common features of motor skill interventions. Scoping reviews may precede systematic reviews with meta-analysis (Munn et al., 2018). It would have been ideal to follow up this scoping review with a systematic review and meta-analysis of motor skill interventions in low- and middle-income countries only. This would provide strong evidence for what is effective in the context of this study. However, only two studies conducted in LMIC were identified across the whole of the scoping review (Ferguson et al., 2013; Najafabadi et al., 2018).

The topic of motor skill interventions is broad due to the heterogeneity of approaches and methods (Camden et al., 2015; Hillier, 2007; Riethmuller et al., 2009; Ward et al., 2017). However, the analysis of intervention parameters, such as timing and frequency of sessions, treatment venues, treatment facilitators, and treatment media/activities used, provided more insight into the practical application of the methods. Timing and frequency of inputs were further described according to each individual approach and presented in a table with clear descriptions of approaches (Appendix 15). The table was intended to be included in the published paper, however was omitted at the time of publication Appendix 15: Scoping Review Table.

The scoping review article was approached from the theoretical framework of motor impairment as a hidden disability (Craig et al., 2019), rurality and low socio-economic influences. It was accepted for publication in the *African Journal of Disability* (AOSIS, 2021)

in October 2020. This is an open-access journal with an impact factor of 0.197. This journal was considered following rejection of the paper by three other journals. It was thought that the scoping review may fit in an African context as the other journals considered were international.

The first choice for publication was the journal *Pediatrics* (American Academy of Pediatrics, 2021), which has a high impact factor of 5.487. At the time of submission to *Pediatrics*, the paper was written in a more general sense and intended to reach a wide audience with a broad pediatric interest. Following an update of the scoping review in 2019, the paper was submitted to *Physical and Occupational Therapy in Pediatrics* (Taylor & Francis, 2021b), an open-access journal with an impact factor of 1.54. This journal provides information to therapists on developmental and physical rehabilitation of children, but was not accepted as it was thought by the editor to be too broad and not contributing novel information. The focus of the paper was shifted towards provision of a novel framework for children in a low socio-economic area and the third journal considered was the *British Journal of Occupational Therapy* (SAGE publishing, 2021), as this journal focuses on international relevant research within an occupational therapy context. The scoping review was not accepted by the editor who suggested improved presentation of methods and results.

The scoping review article can be viewed at: https://ajod.org/index.php/ajod/article/view/747

The MS Excel data worksheet can be accessed at:

https://stellenbosch-my.sharepoint.com/personal/17390885_sun_ac_za/_layouts/15/Doc.aspx?OR=teams&action=edit&sourcedoc={C524F83A-A583-40D1-93A4-1C86D4B70F01}

Published paper 2: Motor skill intervention for pre-school children: A scoping review

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AOSIS

Page 1 of 8 Review Article

Motor skill intervention for pre-school children: A scoping review

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Background: There is a high prevalence of motor skill difficulties amongst pre-school children living in low socio-economic areas. Motor skill impairment can affect these children's school readiness and academic progress, social skills, play and general independence.

Objectives: This scoping review investigates the key elements of existing motor skill interventions for pre-school children.

Method: We gathered information through structured database searches from Cinahl, Eric, PubMed, Cochrane, ProQuest, Psych Net, PEDro and Scopus, using a keyword string. The PRISMA-SCR design was used to identify 45 eligible studies. All included studies investigated a motor skill intervention with well-defined outcome measures for children aged 4–7 years with motor skill difficulties. Studies that exclusively focused on children with neurological conditions such as cerebral palsy, physical disabilities or medical/physical deteriorating conditions were excluded. Information was charted on MS Excel spreadsheets. Fundamental concepts were categorised into common key themes and were converted into a proposed framework.

Results: Fifteen intervention approaches were identified. Treatment is mostly managed by occupational therapists and physiotherapists. Evidence supports individual and group treatment with a child-centred, playful approach in a school or therapeutic setting. Whilst session information varied, there is moderate evidence to suggest that a 15-week programme, with two weekly sessions, may be feasible.

Conclusion: Children with motor skill difficulties need therapeutic intervention. This study identified the key elements of existing therapy intervention methods and converted it into a proposed framework for intervention planning. It is a first step towards addressing motor skill difficulties amongst pre-school children in low socio-economic areas.

Keywords: motor skill difficulties; intervention methods; pre-school children; low socio-economic area; framework; scoping review.

Introduction

Motor skills development refers to the acquisition of gross and fine motor skills. Impairment in areas such as balance, coordination and eye–hand coordination may impact on play (Cairney et al. 2010), peer relationships (Wagner et al. 2012), independence skills (Van der Linde et al. 2015) and academic progress (Cameron et al. 2012). These difficulties persist into primary and secondary school (Harrowell et al. 2018), and therapeutic input is essential as children do not just grow out of these difficulties (Hillier 2007). Early support and intervention could help to prevent children failing and reduce the dropout rates throughout the school years (Wills 2016). Unfortunately, motor skill impairment is an often hidden disability.in developmental disorders such as Developmental Coordination Disorder (DCD), Attention Deficit and Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD) and language disorders. Children with Foetal Alcohol Syndrome (FAS) and Human Immunodeficiency Virus (HIV)/Acquired Immune Deficiency Syndrome (AIDS) also experience motor impairments. These two conditions have a high prevalence in low- and middle-income countries (LMIC) (Garrib et al. 2006; Van Rie, Mupuala & Dow 2008; Olivier, Curfs & Viljoen 2016).

Low socio-economic status increases the risk of motor skill impairment amongst children. A Brazilian study used the Movement Assessment Battery for Children (MABC) and found a prevalence of 33% of DCD/probable DCD amongst socially disadvantaged children

Note: Additional supporting information may be found in the online version of this article as Online Appendix 1 and Online Appendix 2.

(4–10 years) (Valentini, Clark & Whitall 2015). A prevalence study in South Africa's West Coast indicated a prevalence of 14.5% of motor skill difficulties amongst pre-school children (Van der Walt, Plastow & Unger 2020). Valentini et al.'s study (2015) catagorised children who scored below the 15th percentile on the MABC as having probable DCD or being at risk of DCD, whilst Van der Walt et al. (2020) acknowledged a wider range of possible causes under the umbrella term of motor skill difficulties (scores < 15%). These prevalence figures are high when compared to high-income countries (HIC). A population-based study in the United Kingdom using the DSM-IV criteria indicated DCD prevalence of 1.7% at age 7 (Lingam et al. 2009), whilst a recent DCD overview reports that up to 7% of school-aged children have DCD (Caçola & Lage 2019). Morley et al.'s UK-based study (2015) assessed the motor proficiency of children (4–7 years) using the Bruininks-Oseretsky Test of Motor Proficiency-2. Results indicated that low socio-economic status in HIC also significantly affects the development of movement skills ($p < 0.001$).

The motor skills of children living in poverty can further be affected by nutrition, relationships and play opportunities (Worku et al. 2018; Van der Walt et al. 2020). For example, a cross-sectional descriptive prevalence study, using multi-stage clustering by Van der Walt et al. (2020), found that pre-school children with limited access to a playground scored significantly lower on fine motor skill subtests of the MABC-2 than peers who had access to a playground ($p = 0.009$). Scores on balance subtests were also lower. However, scores for ball skills were on par or in some individuals better than their peers who did have playground access ($p = 0.36$). We believe that this is most likely because balls are readily available in these settings, despite poverty.

Literature on motor skill interventions mainly focuses on treatment approaches and programmes used to address difficulties associated with DCD (Camden et al. 2014; Case-Smith, Frolek Clark & Schlabach 2013; Hillier 2007; Mandich et al. 2001; Smits-Engelsman et al. 2018). Other studies focus on Fundamental Movement Skills interventions, which are interventions geared at developing the foundation skills needed for sport participation in school and in later years (Jones et al. 2011; Pope et al. 2011). A systematic review (Veldman, Jones & Okely 2016) investigated the efficacy of gross motor skill interventions in early childhood settings, but excluded studies that included children with health problems or with certain diagnoses, for example, autism, where motor skill difficulties may be co-morbid. The studies highlighted the importance of therapist, teacher and parent involvement as well as methodological sound interventions, whilst also emphasising the lack of quantity and quality interventions aimed at addressing motor skill difficulties. A recent systematic review by Eddy et al. (2019) focussed specifically on the effectiveness of school-based interventions for children aged 3–12 years. The study concluded that, although school-based interventions overall had positive outcomes, the level of benefit depended on the type of intervention. The authors recommend further research to determine dosage and intensity of interventions, and comparison between targeted and universal interventions. Nevertheless, this systematic review only included case-control and randomised studies published between 2012 and 2017.

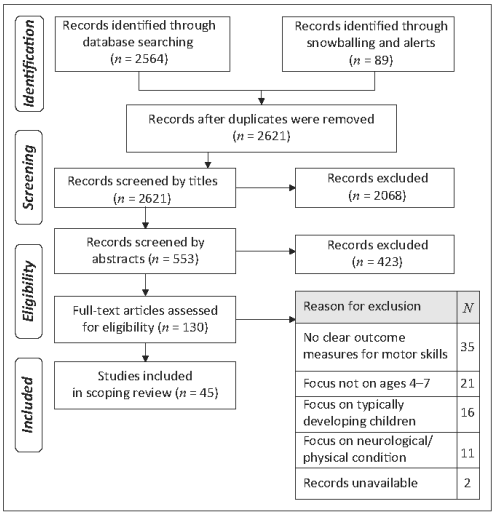
This scoping review investigates the key characteristics and features of motor skill interventions for pre-school children conducted in any setting, up to May 2019, to inform a best practice model that can be adapted for specific communities. Because of the wide range of diagnoses, types of interventions, disciplines treating motor skill impairment and intervention settings, a scoping review was the preferred methodology (McKinstry et al. 2014; Pham et al. 2014). This review may inform future studies focused on specific interventions or intervention characteristics.

Method

The aim of this scoping review was to identify the key features of interventions for improving motor proficiency in pre-school children. The study followed the PRISMA-SCR guidelines (Tricco et al. 2018) and the six stages of planning a scoping review as described by Levac et al. (2010).

The following research questions were considered: What interventions exist aimed at improving motor skills in pre-school children? How are these interventions provided in terms of frequency, duration, method, intervention provider and treatment setting? What is the level of evidence for these interventions? and What are the recommendations for implementation of these interventions?

Relevant studies were identified by searching through the following database accessible through Stellenbosch University's library – Cinahl, Eric, PubMed, Cochrane, ProQuest, Psych Net, PEDro and Scopus – using the keywords motor skills, motor impairment, gross motor skills, fine motor skills, treatment, intervention and children. Filters were applied for database searches – an example of a database search is available (Online Appendix 1). Records were included when available in English or translated to English. Any outcome-based method of intervention aimed at improving motor skills in children between 4 and 7 years of age was included. These included randomised controlled trials (RCTs), case-controlled studies and quasi-experimental studies that aimed to determine the effect of an intervention to improve motor skills and using standardised outcomes to measure effect. Study participants had to present with a motor skill delay or at least a risk of motor skill delay at the onset of a study. Studies investigating only typically developing children and studies that exclusively focused on a neurological condition, physical disability or physical/medical deteriorating condition were excluded. Literature reviews, systematic reviews and meta-analyses were also considered. Grey literature was considered; however, none of these studies adhered to the inclusion criteria.



Source: PRISMA adapted from Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gøtzsche, P., Ioannidis, J. et al, 2009, 'The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration', *PLoS Medicine* 6(7), e1000100. https://doi.org/10.1371/journal.pmed.1000100; and, Hohlfeld, A.S.J., Harty, M. & Engel, M.E., 2018, 'Parents of children with disabilities: A systematic review of parenting interventions and self-efficacy', *African Journal of Disability* 7(0), a437. https://doi.org/10.4102/ajod.v7i0.437

FIGURE 1: Flow diagram of search strategy.

Additional articles/studies were also found using snowballing and pearling (Hadfield 2019) by searching through the references of included studies and following up on alerts from database. Search results were saved and organised in the reference manager software database of Mendeley (Elsevier 2020). The latest database search was completed in April 2019.

Records were screened by title and abstract first and then by full articles. The main screening process was carried out by the primary researcher. The records were sent to two co-researchers to review where there was any uncertainty and were included in the study when agreed by both as suitable. Refer to Figure 1 for a description of the search strategy (Liberati et al. 2009).

The researchers developed an MS Excel custom spreadsheet for data capturing. The primary researcher piloted the spreadsheet, which was then reviewed by two secondary reviewers. The final spreadsheet contained 18 main headings. Included studies were classified according to the National Health and Medical Research Council (NHMRC) hierarchy of evidence (Merlin, Weston & Tooher 2009), which grades studies from level I (highest level) to IV (lowest level) – see Online Appendix 2. Critical appraisal of included studies was not done as these are not typically completed in scoping reviews (Arksey & O'Malley 2005; Pham et al. 2014).

The nature of each study was analysed by type (research method) and theme (main idea of the study). Numeric coding was used to assign each study to a category by deductive analysis. Demographic information was charted according to

BOX 1: Evidence-based recommendations for motor skill interventions.

1. Therapeutic input to improve motor skills

- Children with motor skill difficulties need specific therapeutic input to make progress and to avoid regression. They will not grow out of the problem. (Bardid et al. 2013; Goodway, Crowe & Ward 2003; Rintala et al. 1998).
- Current known interventions used to improve motor skills are overall positive with no one intervention being significantly superior to another. (Case-Smith 2000; Case-Smith et al. 2013; Hillier 2007; Logan et al. 2012; Mandich et al. 2001; May-Benson & Koomar 2010).
- Cognitive approaches deliver overall positive results. (Mandich et al. 2001; Niemeijer et al. 2006; Smits-Engelsman et al. 2013).
- Treatment methods based on rhythm and timing have proved to be successful (Bardid et al. 2013; Cosper, Lee, Peters & Bishop 2009; Leemrijse et al. 2000).
- A pure sensory integration (SI) approach is not indicated but SI principles should be included in an eclectic approach (Smits-Engelsman et al. 2013)
- Children with Autism Spectrum Disorders (ASD) will benefit from a motor skill programme to address motor skill difficulties (Bremer, Balogh & Lloyd 2015). An SI approach specifically benefit children with ASD (Iwanaga et al. 2014; Pfeiffer et al. 2011)
- Daily doses of methylphenidate may be useful in children with comorbid ADHD and motor skill difficulties (Bart et al. 2010; Smits-Engelsman et al. 2013).
- A motor learning approach was shown to be successful. (Bardid et al. 2013; Smits-Engelsman et al. 2013)
- Structured programmes with specific research-based aims (such as NTT) should be used when developing a programme to address motor skill difficulties rather than unstructured activities such as gaming (Ferguson et al. 2013).

2. Interpersonal and social approaches

- Group therapy and a playful, child-centred approach are indicated as play and peer interaction has a positive effect on motor skill improvement in treatment (Case-Smith 2000; Kirk & Rhodes 2011; Lahav et al. 2008)
- There is positive evidence for a small therapy group (Smits-Engelsman et al. 2018)

3. Components of therapeutic input to improve motor skills

- Comprehensive occupational therapy intervention results in significant gains in motor and functional skills (Bazyk et al. 2009; Case-Smith 2000; Case-Smith et al. 1998; Case-Smith 1996)
- Comprehensive and integrated occupational therapy input, using various and/or combined approaches, benefits motor skills as well as literacy skills (Bazyk et al. 2009).
- Indirect therapy though advice and contributions to a child's Individual Education Plan (IEP) improves functional skills but does not directly improve fine motor skills (Bayona et al. 2006).
- A good occupational therapy consultation service (to a school) can have a positive effect similar to a direct therapy service (Dreiling & Bundy 2003).
- There is positive evidence for a school-based approach (Kirk & Rhodes 2011)

numeric codes developed as records were analysed. The same process was used to plot data relating to interventions (venue, facilitator, structure and equipment required). For diagnoses and treatment approaches, inductive reasoning was applied to list all possible options to incorporate the possibility for several approaches/diagnoses in a study. This was a fluid and progressive process until all records were analysed. Nominal data were input directly for age, group size and session information. Data were analysed by calculating either the total, percentage, mean, median or range according to data sets. Programme duration and session information (quantity, duration and frequency) were calculated across approaches by mean, standard deviation, median and range as can be seen in Online Appendix 2. Additional important information was summarised for each study, categorised and coded accordingly to create a summary of evidence-based recommendations (Box 1).

Results

Description of included studies

Database searches identified 2564 records with 89 added through snowballing and alerts. Thirty-two duplicates were removed. Title and abstract screening reduced the number for full article review to 130. A final number of 45 articles

were included in this scoping review (Figure 1). According to the NHMRC hierarchy of evidence (Merlin et al. 2009), there were no studies included in this scoping review that qualified as a Level I study given the absence of systematic reviews of *only* RCTs. Eight studies were graded as Level II with evidence from at least one properly designed RCT. Thirty-four studies were classified as Level III (1–3) studies, using pseudo-RCTs, cohort studies and outcome-based studies with non-randomised allocation of concurrent controls, comparative studies with a historical control or interrupted time series without a parallel control group. A literature review that included only Level III studies was classified at Level III. Three studies were case series, with pre-post or post testing, and were classified at Level IV. A complete description of studies with assigned quality levels is available in Online Appendix 2.

Only two studies included in this review were conducted in LMIC, namely South Africa (Ferguson et al. 2013) and Iran (Najafabadi et al. 2018). Twenty-four studies were conducted in the United States of America, four studies each in Canada and Israel and three in the Netherlands. The remaining studies were from Japan (2), Belgium (2), Australia (2), and one each from Finland and Sweden.

Studies referred to a specific diagnosis or included more than one diagnosis. The diagnostic group most frequently referred to was DCD (14 studies). In 11 studies, children were described as having problems with motor skills, but not diagnosed, and the label of motor skill difficulties was assigned. Studies including children with ASD (10) and ADHD (2) as well as those with developmental delay (11) or being at risk of developmental delay (6) were also described. Other diagnoses included: Down's syndrome (2), Sensory Processing Disorder (1), Learning Difficulties (1) and Developmental Language Disorder (1).

Description of data relating to treatment interventions

Studies often referred to more than one intervention approach. The most common approach described was a visual-perceptual motor approach investigated in 30 studies. Fifteen studies referred to a sensory integration approach and 13 to task-specific training. An indirect approach through training, advice, contributing to individual education plans and physical education (PE) was investigated in eight studies and a cognitive-motor approach in another seven studies. Mastery and neuro-motor task training were investigated in four studies. The remaining studies included virtual gaming (3), direct instruction (2), approaches focusing on rhythm and timing (2), pharmaceutical intervention (2), equestrian therapy (1) and body function-orientated input (1). Approaches are described in Online Appendix 2.

All included studies reported to have had a positive influence on motor skills through means of various study designs. Sixteen of the studies explored the effect of a specific approach or programme on the motor skills of children. Eight studies investigated the effectiveness of services or programmes and focussed mainly on positive contributing factors. Five studies investigated the effect of instructional and motivational aspects when implementing a programme. Studies often reported on one approach to be more effective than another according to intervention implementation models or structural elements (6). One study investigated the effect of gender on motor skill intervention. One meta-analysis, three systematic reviews, two combined systematic reviews and meta-analyses and two other comprehensive reviews compared studies for a variety of reasons and described both positive and negative outcomes.

Intervention parameters such as timing and frequency of inputs according to each approach are described in Online Appendix 2. The total number of sessions over all named approaches varied significantly and ranged from 3 to 130 sessions with a mean of 24 and SD of 17 (24 ± 17). The duration of the intervention also varied and ranged from 3 to 40 weeks (15 ± 6). The number of sessions per week ranged from one to five sessions per week (2 ± 1). The session duration varied from 10 to 240 min per session (46 ± 17).

The main facilitators of treatment in these studies were occupational therapists (OTs) (16), followed by physiotherapists (PT) (5) or combined OT and PT input (4). In four studies OTs/PTs and teachers were co-facilitators. Kinesiologists facilitated the treatment in three studies, educators (PE and class teachers) in seven and specialised therapists (e.g. equestrian or hippotherapy) in four. Three studies did not mention who facilitated the sessions.

Intervention programmes were typically carried out in the school environment (17 studies), therapeutic setting (13) or at both (4). Three studies mentioned home programmes as part of an intervention, whilst eight studies did not mention therapy venues. There was poor description of activities used in the interventions and authors were contacted through email to provide more detail (Bazyk 2017). Refer to Online Appendix 2 for detail of activities where these were reported.

The data as described above was summarised in a proposed framework focussing on common features of motor skill interventions for pre-school children (Figure 2). The framework enables one to find and plan motor skill intervention for a specific service or area by 'filtering' location, environment and resources. Location refers to the geographical area (e.g. rural vs urban), environment to the conditions under which intervention is planned (educational vs therapeutic, diagnoses or identified difficulties, time, age group, etc.) and resources to funding, equipment and staff available. Important additional information was categorised into the three areas of therapeutic input, interpersonal/social approaches and components of therapy input (Box 1).

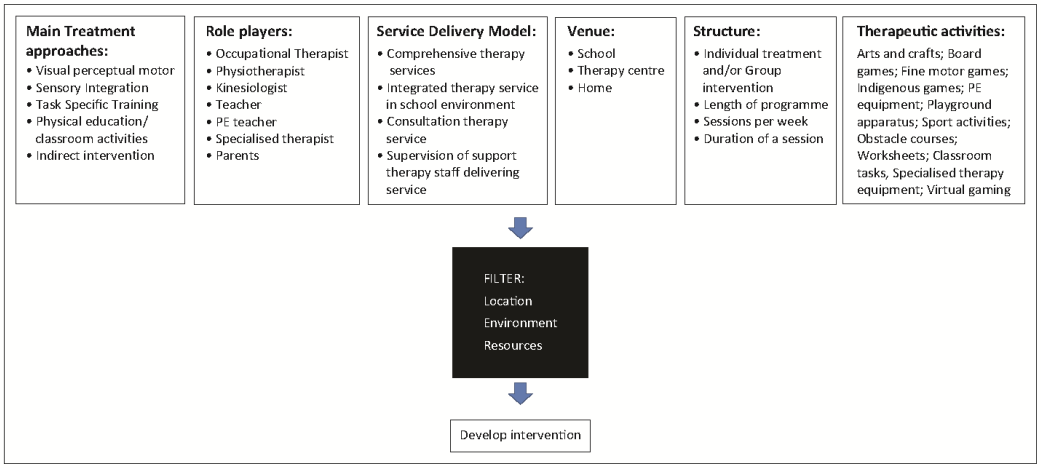


FIGURE 2: A proposed framework of components to consider for motor skill interventions planning for pre-school children.

Discussion

To address the hidden disability of motor skills impairment that is experienced by young children with a range of other health conditions, we need to have a framework to inform the choice of approaches that will work best within their own context. This is particularly important when resources, including professional expertise, are limited. The proposed framework, as seen in Figure 2, gives guidance on service and programme development in different contexts, whilst promoting evidence-based practice. We recommend that when developing programmes to address motor skill impairment in young children, professionals consider the treatment approach(es) to be used, the key role players available, how and where services will be delivered, the structure of the intervention programme and the contextually relevant activities that will be used during intervention.

Approaches used in the studies identified in this review varied, but results suggested some positive outcomes in all the studies. This correlates with three systematic reviews (Eddy et al. 2019; Hillier 2007; Logan et al. 2012) that indicated that most interventions have positive outcomes. When looking at specific populations however, certain approaches may be more effective than others. Sensory integration is shown to be effective for children with ASD (Iwanaga et al. 2014), whilst medication may benefit children who experience both motor skill difficulties and attention and concentration deficits (Bart, Podoly & Bar-Haim 2010). A systematic review of high-quality RCTs investigating motor skill interventions for school-going children with DCD found that all effective interventions had a task-orientated approach, but also stated that even within the diagnoses of DCD, heterogeneity should be considered (Preston et al. 2017). A playful, child-centred approach may have a positive influence on motor skill therapy outcomes (Case-Smith 2000; Kirk & Rhodes 2011; Lahav, Apter & Ratzon 2008). For a diverse population with motor skill difficulties, the researchers theorised that a more eclectic approach is recommended to accommodate individual needs (Mandich et al. 2001).

Occupational therapists, followed by PTs and kinesiologists, were found to be the most prominent providers of therapeutic input. It seems to remain a specialist area of care involving a range of specific assessment and treatment approaches. Teachers are often involved together with a therapist, dependent on the service delivery model. In this study, four main service delivery models are described, namely comprehensive OT services; integrated OT services in a school environment; OT consultation services to schools and service delivery by school assistants under supervision of PTs. The level of resources regarding therapists, time and funding is important to consider when implementing best practice. In a low socio-economic area, a task shifting approach (World Health Organization 2008) may be indicated, where teachers are trained to facilitate an intervention with guidance and support from therapists. It should be kept in mind that not all role players in the treatment of motor skill difficulties were included in the review as studies are not available or not fitting the inclusion criteria. Other factors that significantly impact on child development should also be considered (Worku et al. 2018). For example, in areas with a high incidence of alcohol and drug use amongst adults, and high unemployment figures, the involvement of social workers may be beneficial. In rural communities, clinic nurses and doctors may also play a valuable role, whilst pediatricians and child psychiatrists play a role where medication is required (Bart et al. 2010).

From this review, it seems that most interventions occurred either in school settings or at therapeutic centers. Programmes may also include home activities (Hillier 2007). Socio-economic factors, accessibility and therapeutic resources were influencing factors.

Therapeutic activities varied from general arts and crafts (Parush & Hahn-Markowitz 1997), games, sport and gross motor apparatus (Pless et al. 2000) to specialised sensory integration equipment (Iwanaga et al. 2014) and virtual gaming (Salem et al. 2012). One should also consider evidence from a study that suggests that a gross motor programme could have the same effect on fine motor skill development than a programme focusing on fine motor tasks (Parush & Hahn-Markowitz 1997). Although more evidence is needed, such a gross motor skill intervention may simplify the process whilst still offering the same benefits. Looking at dosage parameters, evidence suggests that an intervention programme of 45 min twice a week for 3 to 4 months may be effective.

The country where the studies were conducted should also be considered. Conditions such as DCD, ADHD and ASD are, for example, clearly defined, and diagnostic pathways and treatment regimens are well mapped out within the unique health and education systems in countries such as the United States (CDC 2020) and the United Kingdom (NICE 2020). Diagnostic and intervention pathways in LMIC are less clearly defined and very little statistical information is available regarding developmental diagnostic groups. For example, no prevalence statistics are available regarding DCD or ASD in South Africa (Lamb 2017). It is therefore difficult to focus an intervention programme to a specific diagnostic group when many children with DCD and ASD remain undiagnosed, and many others may have comorbidities such as HIV and FAS affecting motor skills development (Olivier et al. 2016; Smith et al. 2002). In LMIC countries, the term 'motor skill difficulties' is also likely to include a wide range of difficulties that may differ from those reported in HICs and thus the outcome of studies from HICs should be interpreted with caution.

The lack of Levels I and II studies (refer to Online Appendix 2) suggests a lack of strong evidence. More RCTs and/or systematic reviews of RCTs, concerning treatment interventions aimed at improving motor skills for pre-school aged children, are recommended to enable more informed decisions regarding best practice interventions for various settings.

Limitations

Research to date concerning motor skill performance in pre-school children and the effectiveness of treatment methods stems predominantly from HIC. As only English published data were included from limited database in this review, unknown valuable data concerning interventions from developing countries not formally or yet published may exist. There is also little known about the effect of multidisciplinary early intervention collaboration. Although the occupational therapy process seems to be crossing borders with physiotherapy and education, there is even less documented data about other supportive role players such as dieticians, speech and language therapists and psychology services.

Conclusion

This study identified key concepts that may be associated with successful interventions for improving motor skills in pre-school children. The key concepts were used to assist in developing a proposed framework for intervention design and implementation in a variety of settings. This review and framework may be useful to guide the development of new intervention strategies specific to the needs of a community. The review highlights the need for further research within LMIC and also with regard to other role players as part of the multidisciplinary team.

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Authors' contributions

Mrs van der Walt conceptualised and designed the study, collected data and carried out the initial analyses, drafted the initial manuscript and reviewed and revised the manuscript.

Drs Plastow and Unger coordinated and supervised the study including conceptualisation and data collection and critically reviewed the manuscript for important intellectual content and reviewed and revised the manuscript.

All authors approved the final manuscript submitted and agreed to be accountable for all aspects of the work.

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Data availability

The data that support the findings of this study are available from the corresponding author, Janke van der Walt, upon reasonable request.

Disclaimer

The authors hereby declare that the views expressed in the submitted article are their own and not an official position of Stellenbosch University.

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ONLINE APPENDIX 1

Note: This is Online Appendix 1 of Van der Walt, J., Plastow, N.A. & Unger, M., 2020, 'Motor skill intervention for pre-school children: A scoping review', *African Journal of Disability* 9(0), a747. https://doi.org/10.4102/ajod.v9i0.747

Full data base search information (Pubmed)

11/05/2016: **Pubmed ((“motor skills” OR “motor impairment” OR gross motor skills” OR fine motor skills”) AND (treatment OR intervention OR approach) AND children**

Full search details with restrictions:

("motor skill*"[All Fields] OR "motor impairment*"[All Fields] OR "gross motor skills"[All Fields] OR "fine motor skills"[All Fields]) AND (("therapy"[Subheading] OR "therapy"[All Fields] OR "treatment"[All Fields] OR "therapeutics"[MeSH Terms] OR "therapeutics"[All Fields]) OR (intervention[All Fields] OR intervention'[All Fields] OR intervention''[All Fields] OR intervention'elles[All Fields] OR intervention'on[All Fields] OR intervention's[All Fields] OR intervention5[All Fields] OR intervention8[All Fields] OR interventiona[All Fields] OR interventionable[All Fields] OR interventional[All Fields] OR interventional'[All Fields] OR interventionalbronchoscopic[All Fields] OR interventionalcardiology[All Fields] OR interventionale[All Fields] OR interventionalgroup[All Fields] OR interventionalism[All Fields] OR interventionalist[All Fields] OR interventionalist's[All Fields] OR interventionalisten[All Fields] OR interventionalistic[All Fields] OR interventionalists[All Fields] OR interventionalists'[All Fields] OR interventionalists's[All Fields] OR interventionall[All Fields] OR interventionalle[All Fields] OR interventionally[All Fields] OR interventionalneuroradiology[All Fields] OR interventionalpatent[All Fields] OR interventionalpulmonology[All Fields] OR interventionalradiologie[All Fields] OR interventionalradiologists[All Fields] OR interventionalradiology[All Fields] OR interventionalradiologystaff[All Fields] OR interventionals[All Fields] OR interventionalsciences[All Fields] OR interventionaltherapies[All Fields] OR interventionaltrade[All Fields] OR interventionand[All Fields] OR interventionare[All Fields] OR interventionary[All Fields] OR interventionas[All Fields] OR interventionat[All Fields] OR interventionbehavioural[All Fields] OR interventionboth[All Fields] OR interventionclinicaltrials[All Fields] OR interventioncodeoperator[All Fields] OR interventiondal[All Fields] OR interventiondata[All Fields] OR interventiondepartment[All Fields] OR interventiondescription[All Fields] OR interventiondevelopment[All Fields] OR interventiondid[All Fields] OR interventioned[All Fields] OR interventionel[All Fields] OR interventionele[All Fields] OR interventionell[All Fields] OR interventionella[All Fields] OR interventionelle[All Fields] OR interventionellem[All Fields] OR interventionellen[All Fields] OR interventioneller[All Fields] OR interventionelles[All Fields] OR interventionem[All Fields] OR interventionen[All Fields] OR interventionentitled[All Fields] OR interventioner[All Fields] OR interventionexternal[All Fields] OR interventionfive[All Fields] OR interventionfor[All Fields] OR interventionfortification[All Fields] OR interventionfudan[All Fields] OR interventiongroup[All Fields] OR interventioni[All Fields] OR interventionial[All Fields] OR interventionin[All Fields] OR interventioninchest[All Fields] OR interventionincluded[All Fields] OR interventioning[All Fields] OR interventionis[All Fields] OR interventionism[All Fields] OR interventionist[All Fields] OR interventionist's[All Fields] OR interventionisten[All Fields] OR interventionistic[All Fields] OR interventionists[All Fields] OR interventionists'[All Fields] OR interventionl[All Fields] OR interventionlist[All Fields] OR interventionmade[All Fields] OR interventionmodels[All Fields] OR interventionnal[All Fields] OR interventionnel[All Fields] OR interventionnele[All Fields] OR interventionnelle[All Fields] OR interventionnelles[All Fields] OR interventionnels[All Fields] OR interventionnine[All Fields] OR interventionnisme[All Fields] OR interventionniste[All Fields] OR interventionnistes[All Fields] OR interventionon[All Fields] OR interventionone[All Fields] OR interventionor[All Fields] OR interventionoutcomesplow[All Fields] OR interventionpatients[All Fields] OR interventionpelvic[All Fields] OR interventionplanner[All Fields] OR interventionpregnant[All Fields] OR interventionrelated[All Fields] OR interventionresearch[All Fields] OR interventionrr[All Fields] OR interventions[All Fields] OR interventions'[All Fields] OR interventions,[All Fields] OR interventions1[All Fields] OR interventions4[All Fields] OR interventions`effect[All Fields] OR interventionsa[All Fields] OR interventionsaimed[All Fields] OR interventionsall[All Fields] OR interventionsalthough[All Fields] OR interventionsamong[All Fields] OR interventionsanalyse[All Fields] OR interventionsand[All Fields] OR interventionsangebotes[All Fields] OR interventionsangiologie[All Fields] OR interventionsansatz[All Fields] OR interventionsansatze[All Fields] OR interventionsansatzen[All Fields] OR interventionsbedarf[All Fields] OR interventionsbedarfs[All Fields] OR interventionsbedurfnissen[All Fields] OR interventionsbedurftigem[All Fields] OR interventionsbeginn[All Fields] OR interventionsbegleitende[All Fields] OR interventionsbehandling[All Fields] OR interventionsbeschreibung[All Fields] OR

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ONLINE APPENDIX 2

Note: This is Online Appendix 1 of Van der Walt, J., Plastow, N.A. & Unger, M., 2020, 'Motor skill intervention for pre-school children: A scoping review', *African Journal of Disability* 9(0), a747. https://doi.org/10.4102/ajod.v9i0.747

TABLE 1-A1: Description of records.

Authors	Title	Type	Level of evidence*	Activities/approaches	Outcome
Colombo-Dougovito A M, Block M E (2019)	Fundamental motor skill interventions for children and adolescents on the autism spectrum: a literature review	Literature Review (5 studie) Quasi-experimental (2) Case studies (2) Multiple method s(1)	III-2	Physical education and adapted physical education lessons Classroom Pivotal Response Teaching Therapy (CPRT)	All included studies reported positive effects following motor skill interventions. Measurements used: Peabody Developmental Motor Scales -2 (PDMS-2), Test of Gross Motor Development second edition (TGMD), Movement Assessment Battery for Children (M-ABC)
Smits-Engelsman B, Vincon S, Blank R, Quadrado V H, Polatajko H, Wilson P (2018)	Evaluating the evidence for motor-based interventions in developmental coordination disorder: A systematic review and meta-analysis	Systematic review and meta-analysis (30 studies 25 datasets) [1]RCT (1) [2]CCT (10) Case study[3]/NCT(5)	II	Virtual Reality Training Sport/play exercises e.g. physio ball/theraband exercises Taekwando Handwriting training Functional Movement Power training Balance training circuit Trampoline	The overall effect size (cohen's d) was high (1.06) There was evidence for positive benefits for activity-oriented approaches, body function-oriented combined with activities, active video games, and small group programmes
Najafabadi M G, Sheikh M, Hemayattalab R, Memari A, Aderyani M R, Hafizi F (2018)	The effect of SPARK on social and motor skills of children with autism	Comparative study (pre-test–post-test, two-group control study design)	III-1	Sports, Play and Active Recreation for Kids (SPARK) programme. Health-fitness activities: 13 activities including aerobic dance, running games, jump ropes. Skill-fitness: 9 sports including soccer, frisbee, basketball. Control group continued with normal PE activities	Significant improvements were found (between pre and post-test scores) in dynamic balance ($p < 0.001$), static balance ($p < 0.001$) and bilateral integration ($p = 0.049$) as measured with the Bruininks–Oseretsky Test of Motor Proficiency (BOTMP) Significant differences were found between the experimental and control group scores on static and dynamic balance ($p < 0.001$) The Autism Treatment Evaluation checklist (ATEC) questionnaire and Gilliam Autism rating Scale 2nd edition (GARS-2) showed a positive effect on social interaction ($p < 0.001$)

[1] RCT: Randomised-control trial
[2] CCT: Controlled clinical triall
[3] NCT: Non-control trial

Van Cappellen van Maldegem S J M, van Abswoude F, Krajenbrink H, Steenbergen B (2018)	Motor learning in children with developmental coordination disorder: the role of focus, attention and working memory	Quasi-experimental field based study Pre-post design	III-2	Slingerball throwing task (target throw) Group 1: received feedback with internal focus of attention while group 2 received feedback with external focus of attention	According to the Movement Assessment Battery for Children 2nd edition (M-ABC 2) accuracy improved for both groups ($p = 0.24$), however there was no significant effect for type of focus of attention ($p = 0.785$) There was a significant effect of visuospatial working memory on learning ($p < 0.01$) (Automated Working Memory Assessment – AWMA) Children receiving feedback with external focus of attention improved more if they has a better visuospatial working memory ($p < 0.01$), however this was not the case for children receiving feedback with internal focus of attention ($p > 0.05$)
Ketchesen L., Hauck J, Ulrich D (2017)	The effects of an early motor skill intervention on motor skills, levels of physical activity, and socialization in young children with autism spectrum disorder: A pilot study.	Pilot study (pre-test–post-test, two-group control study design)	III-2	Classroom Pivotal Response Teaching (CPRT) Locomotor skill and object control skill training – free play and indirect instruction	Significant difference between groups in three motor components: Locomotor: $p < 0.001$; object control: $p < 0.001$; gross quotient : $p < 0.01$ as measured with[4] TGMD - 2
Ward E, Hillier S, Raynor A, Petkov J (2017)	A range of service delivery models for children with developmental coordination disorder are effective: a randomized controlled trial	Randomised Controlled Trial	II	All groups: Fine motor warm up: e.g. playdough Fine motor task e.g. collage Body awareness task e.g. animal walk Gross motor warm up e.g. scooter board Gross motor circuit Modes of delivery: 1. In school with a support worker 2. In school with a physical therapist In clinic with a physical therapist	Overall significant improvement of motor skills as measured with the M-ABC ($p=0.00$) and TGMD-2 ($p=0.00$) over time and improvement was maintained or increased after a 6 month period (M-ABC effect size = 0.98; [5]TGMD-2 effect size 1.37) There was no group effect between modes of intervention ($p = 0.09$)
Lowe L, MacMillian AG, Yates C (2015)	Body Weight Support Treadmill Training for children with developmental delay who are ambulatory.	Experimental/Outcome study – sample of convenience with computer generated randomization	III-1	All subjects continued with physiotherapy sessions as usual. Experimental group received up to 3 additional Body Weight Support Treadmill Training (BWSTT) sessions weekly	Significant improvement was seen in gait velocity ($p = 0.033$) and gross motor skill attainment ($p = 0.017$) when compared with control group as measured with a 10m walking test and the Gross Motor Function Measure, E.

[4] TGMD – 2: Test of Gross Motor Development second edition
[5] TGMD-2: Test of Gross Motor Development second edition

Bremer E, Balogh R, Lloyd M (2015)	Effectiveness of a fundamental motor skill intervention for 4-year-old children with autism spectrum disorder: A pilot study	Experimental/Outcome study (waiting list control experimental design)	III-1	Locomotor skills (running, hopping, leaping), object control (ball skills), obstacle courses, free play Group 1 received treatment first, while group 2 acted as control group. Group 2 received the same input on completion of the first group's treatment	Significant improvement of the object manipulation raw score (p = 0.029) and total motor quotient (p = 0.044) of the[6] PDMS-2, when compared to the control group.
Iwanaga R, Honda S, Nakane H, Tanaka K, Toeda H, Tanaka G (2014)	Pilot study: Efficacy of sensory integration therapy for Japanese children with high-functioning autism spectrum disorder	Pilot study: (quasi-experimental design)	III-2	Sensory Integration (SI) therapy: Use of sensory and kinetic equipment such as a swing, ball pit, balance beam, ladder and trampoline. Specific SI treatment principles applied. 3. General treatment programme: social skills and communication training, kinetic activities, child-parent play. Some SI principles included.	The [7]SI therapy group and general therapy group made significant gains post treatment with the total score of the re-standardised version of the Millers assessment for pre-schoolers (J-MAP) Children who received SI therapy improved significantly more with regards to the total score of the [8]J-MAP (p = 0.005), including the coordination index score (p = 0.008) and the complex index score (p = 0.034)
Ajzenman HF, Standeven JW, Shurtleff TL (2013)	Effect of hippotherapy on motor control, adaptive behaviors, and participation in children with autism spectrum disorder: a pilot study	Pilot study (single group pre-post design)	IV	Functional horse-riding positions on therapy horses; schooling figures, following complex directions, turn taking, planning, and ball games included.	Significant improvement found in postural control through force plates and video motion capture. (p = 0.028)
Bardid F, Deconinck FJA, Descamps S, Verhoeven L, De Pooter G, Lenoir M, et al (2013)	The effectiveness of a fundamental motor skill intervention in pre-schoolers with motor problems depends on gender but not environmental context	Experimental/outcome (Cohort study)	III-2	Intervention: Locomotor skills, ball handling skills, jumping skills, postures and balance, play, rhythm and dance Regular [9]PE Control group: Regular PE	Intervention group: significant improvement of locomotor skills (p < 0.001) and object control (p < 0.001) measured with the [10]TGMD-2 49% achieved an average motor skill level Control group: presented with decline in motor skill level (p = 0.009) Gender: Girls in the intervention group made significant progress with locomotor skills (p = 0.004) and object control (p = 0.004), while boys in the control group did not show significant progress with locomotor skills (p = 0.065 or object control (p = 0.278)

[6] PDMS-2: Peabody Developmental Motor Scales second edition
[7] SI: Sensory Integration
[8] J-MAP: Re-standardised version of the Millers assessment for pre-schoolers
[9] PE: Physical Education
[10] TGMD-2: Test of Gross Motor Development second edition

Case-Smith J, Frolek Clark GJ, Schlabach TL (2013)	Systematic review of interventions used in occupational therapy to promote motor performance for children ages birth - 5 years	Systematic review 24 studies divided into three sections: -Visual–motor interventions for preschool children with developmental delays (4 studies) Non randomised cross-over design Quasi-experimental [11]NCT Single group pre/post –Developmental play-based interventions for infants at risk (5 studies) - Interventions for young children with or at risk for Cerebral Palsy(CP) (15 studies)	II	Visual-motor interventions: Sensory-motor activities Child centred vs therapy directed approach (for the purpose of this scoping review, only this section was found to be relevant)	Visual–motor interventions for pre-school children with developmental delays resulted in positive short-term effects on children's visual–motor performance
Ferguson GD, Jelsma D, Jelsma J, Smits-Engelsman BCM (2013)	The efficacy of two task-orientated interventions for children with Developmental Coordination Disorder: Neuromotor Task Training and Nintendo Wii Fit training.	Comparative study (single-blinded quasi-experimental study design)	III-2	Neuromotor Task Training (NTT): Functional groups with collated goals: soccer, netball, indigenous games. Workstations using basic equipment such a balls, buckets, cups and natural materials such as sticks, planks and bricks to practice components of games Nintendo: Wii fit games	The mean total standard score of the [12]M-ABC 2 of the [13]NTT group improved significantly after intervention (p < 0.01) The Wii fit group did not show significant improvement with the total standard scores, (p = 0.26) but a moderate effect size (d = -0.50)
Smits-Engelsman BC, Blank R, Kaay AC, Mosterd-van der Meijs R, Vlugt-van den Brand E, Polatajko HJ, et al.(2013)	Efficacy of interventions to improve motor performance in children with developmental coordination disorder: a combined systematic review and meta-analysis.	Combined systematic review and meta-analysis 26 studies included 20 studies eligible for meta-analysis Systematic review (1) Meat-analysis (1) [14]RCT's & clinical trials (24)	II	Task orientated approach Motor Imagery Training Perceptual-motor training Process Orientated training (sensory integration) Medication (Methylphenidate) Teacher and parent guidance	Task orientated approaches and motor learning were indicated above other approaches (dw = 0.89 and dw = 0.83 respectively) Task orientated approaches had a significantly higher effect size than process orientated training (p = 0.01) and comparison (p = 0.006)

[11] NCT: Non-control trial
[12] M-ABC2: Movement Assessment Battery for Children second edition
[13] NTT: Neuromotor task training
[14] RCT: Randomised-control trial

Alhassan S, Nwaokelemeh O, Ghazarian M, Roberts J, Mendoza A, Shitole S (2012)	Effects of locomotor skill program on minority pre-schoolers' physical activity levels.	Pilot study Cohort study	III-2	Locomotor skills programme (LMS) -Low intensity music activity -locomotor skills -extension activities (e.g. rodeo galloping.) Control group: supervised free play	Locomotor skills programme: Significant improvement in leaping skills (p = 0.01) when assessed with the [15]TGMD-2 Significant reduction of time spent in sedentary play (p= 0.02) as measured with the Actigraph GTIM accelerometer
Logan SW, Robinson LE, Wilson AE, Lucas WA.(2012)	Getting the fundamentals of movement: a meta-analysis of the effectiveness of motor skill interventions in children	Meta-analysis 11 studies included [16]CCT(4) [17]NCT (5) Quasi-experimental (2)	III-1	Child facilitated Direct instruction Modified direct instruction Mastery Psychomotor training Physical education Music based motor programmes Activity based after school programme Fitness infusion Occupational Therapy programmes	A significant positive effect of motor skill interventions on the improvement of fundamental movement skills in children was found (d = 0.39, p < 0.001) When considered separately, interventions resulted in significant and similar improvements in object control (p < 0.001) and locomotor skills (p < 0.001)
Salem Y, Gropack SJ, Coffin D, Godwin EM (2012)	Effectiveness of a low-cost virtual reality system for children with developmental delay: A preliminary randomised single-blind controlled trial.	Experimental/outcome study Cohort	II	Experimental group: Nintendo Wii gaming system (Wii fit and Wii sports) Control group: Regular occupational therapy /physiotherapy, focus was on facilitation of movement transitions, balance, walking, and gross and fine motor control.	The experimental group exhibited trends towards greater improvements than the control group as measured with the Gross Motor Function Measure (GMFM). Single leg stance test (p = 0.017) Right grip strength (p = 0.024) Left grip strength (p = 0.043)
Golos A, Sarid M, Weill M, Weintraub N (2011)	Efficacy of an early intervention program for at-risk preschool boys: a two-group control study	Comparative study (pre-test–post-test, two-group control study design)	III-1	Intervention: Teacher training, monitoring and collaboration sessions : Graphomotor activities (e.g. colouring within lines), manual dexterity (e.g., cutting), and gross motor activities (e.g., jumping, hopping, balance exercises, ball game Monitoring: Teacher training	The intervention group scored significantly higher than the control group in most performance skills including cognitive tasks (p = 008) (Assessments instruments used: Developmental Test of Visual Motor Integration (VMI), [18]M-ABC,[19] MAP) Significant progress was made with participation and performance (Structured Preschool Participation - Observation: SPO), with a large effect size (h > 0.14 in all)
Kirk MA, Rhodes RE (2011)	Motor skill interventions to improve fundamental movement skills of pre-schoolers with developmental delay	Review 11 studies included [20]RCT (1)	II	Motivational climates: -child directed -facilitator instructed	81% of the studies achieved significant improvement in motor skills, mostly

[15] TGMD-2: Test of Gross Motor Development second edition
[16] CCT: Controlled clinical triall
[17] NCT: Non-control trial
[18] M-ABC: Movement Assessment Battery for Children
[19] MAP: Millers Assessment for Pre-schoolers
[20] RCT: Randomised-control trial

		[21]NRCT (4) Experimental designs (4) Case Report (2)		Physical Therapy Sensory-motor therapy	locomotor skills, up to level of typically developing peers. Intervention effect for trials (N= 9): (η2 = 0.57–0.85).
Pfeiffer BA, Koenig K, Kinnealey M, Sheppard M, Henderson L (2011)	Effectiveness of sensory integration interventions in children with autism spectrum disorders: a pilot study.	Pilot study (comparative study using a sample of convenience)	III-1`	[22]SI intervention: individualised plans, adhering to SI principles, using SI equipment Fine motor intervention: constructional activities, drawing/writing and fine motor crafts	Significant improvements occurred on the Goal Achievement Scale (GAS), including sensory processing, motor skills, and social functioning for both treatments, but more significant changes occurred for the SI group as rated by parents(p<0.5) and teachers (p<0.01)
Bart O, Podoly T, Bar-Haim,Y (2010)	A preliminary study on the effect of methylphenidate(MPH) on motor performance in children with comorbid DCD and ADHD	Preliminary study (a double-blind within-subject research design)	III-2	Ritalin/Concerta as per individual prescribe dosages Control: Placebo tablets	Children who took MPH significantly improved their mean total score with the M-ABC when compared to the group who took placebos (p < 0.02)
May-Benson TA, Koomar JA. (2010)	Systematic review of the research evidence examining the effectiveness of interventions using a sensory integrative approach for children	Systematic review 27 studies including:, i RCT level !(13) Level II (5) Level III (3) Case studies (6) Quality score determined by means of the MacDermid Scale	II	Sensory integration: -SI equipment -sensorimotor play (e.g. ball activity)	Outcomes, including sensorimotor skills and motor planning, related to the SI approach were better than no treatment in >50% of the studies, but not better than alternative treatment methods.
Wuang Y, Wang C, Huang M, Su C (2010)	The effectiveness of simulated developmental horse-riding program in children with autism	Experimental/outcome study (wait list control, pre-post testing)	III-2	Simulated developmental horse riding programme (with Joba equipment) in addition to regular occupational therapy sessions	Both groups made significant gains in motor skills (measured with the [23]BOTMP (p<0.01) and with sensory processing when measured with the Test of Sensory Integration Functions (TSIF) (p <0.1).
Bazyk S, Michaud P, Goodman G, Papp P, Hawkins E, Welch MA (2009)	Integrating occupational therapy services in a kindergarten curriculum: a look at the outcomes.	Outcome study (one group pre-test-post-test)	IV	Indirect: teacher consultation, planning, parent consultation. Direct: Group sessions. Often co-groups with art/music teacher	Significant gains in fine motor skills as measured with the[24] PDMS-2 (p <0.01) were made for all children
Cosper SM, Lee GP, Peters SB, Bishop E (2009)	Interactive metronome training in children with attention deficit and developmental coordination disorders	Experimental/outcome study (pre-test-post-test design)	III-3	Headphones Rhythmic sounds Motion-sensory trigger buttons, which attach either to the hand or foot for use in performing various repetitive patterned activities	Significant improvement were made with visual-motor control (p=0.02) with the BOTMP Significant improvements were made with complex visual choice reaction time on the Continuous Performance Test (p < 0.05) of a vigilance test.

[21] NRCT: Nonrandomised-control trial
[22] SI: Sensory Integration
[23] BOTMP: Bruininks– Oseretsky Test of Motor Proficiency
[24] PDMS-2: Peabody Developmental Motor Scales second edition

Robinson LE, Goodway JD (2009)	Instructional climates in preschool children who are at-risk. Part I: object-control skill development	Comparative study (quasi-experimental design)	III-2	Control group: free play, with access to general playground equipment Low autonomy group: warm up, motor skill stations, closure. Clear directions and instructions. Facilitator indicates when to change stations. Mastery motivational group: Same activities, but students progress independently through activity stations.	Both instructional climate approaches indicated a significant progress (treatment x time interaction: p<0.001) in object control when compared to control group when measured with the [25]TGMD-2. No significant difference between the two approaches i.e. mastery motivational climate and low autonomy (p=0.42)
Lahav O, Apter A, Ratzon N (2008)	A comparison of the effects of directive visuomotor intervention versus nondirective supportive intervention in kindergarten and elementary school children	Comparative study Cohort study	III-2	Directive patterns, paper work and fine motor activities Non directive : mind games, memory games, games of chance, social games, cards, board games Control group: No extra input	Significant improvement in visual motor integration skills (measured with the [26]VMI) with the nondirective approach for Kindergarten learners (p < 0.05) when compared to control group. Significant greater improvement with the non-directive approach when compared to the directive approach (p < 0.05). VMI and Developmental Tests of Visual Perception (DTVP) Grade 1 learners showed a significant greater response with the directive approach when compared to the kindergarten group (< 0.05) and a significant improvement in visual motor integration for both approaches when compared to the control group (< 0.05) Grade 1 learners showed significant greater improvement in visual motor integration with the directive approach when compared to children in Kindergarten (p < 0.05)
Hillier S.(2007)	Intervention for children with developmental coordination disorder: a systematic review.	Systematic review 31 studies Level 1: 1 Meta-analysis Level II 16 [27]RCT's Level III: 14 outcome based studies According to NH-MRC levels of evidence (1999)	II	General occupational therapy Sensory integration Perceptual-motor therapy Kinaesthetic training CO-OP (cognitive orientation to daily occupational performance) Task orientated learning Process orientated learning	Meta-analysis was not possible due to the clinical heterogeneity of the primary studies included. Evidence was considered to be sufficient and of sufficient quality to suggest that all interventions were positive and any of these was considered to be better than no input.

[25] TGMD-2: Test of Gross Motor Development second edition
[26] VMI: Developmental Test of Visual Motor Integration
[27] RCT's: Randomised control trials

				Parent assisted home exercises Physiotherapy Mastery Cognitive-affective tasks Sport activities Task specific training Neuromotor task training Le Bon Depart Teacher/parent guidance	
Bayona CL, McDougall J, Tucker MA, Nichols M, Mandich A (2006)	School-based occupational therapy for children with fine motor difficulties: evaluating functional outcomes and fidelity of services.	Evaluation of service / programme (one-group pre-test-post-test quasi-experimental research design)	III-3	Recommendations to school regarding motor function (in-hand manipulation and motor planning) as well as specific strategies to improve visual perceptual skills. Recommendations for task/environmental changes (e.g. slanted desks) and strategies. All above in form of written home programmes with paper and pencil tasks Limited individual OT sessions	Significant progress was made in written communication as measured with the Vineland Adaptive behaviour Scales – Classroom edition (VABS-C) (p<0.001) Significant improvement with written work and using materials on the School Function Assessment (SFA) (p<0.5)
Niemeijer AS, Schoemaker MM, Smits-Engelsman BCM (2006)	Are teaching principles associated with improved motor performance in children with developmental coordination disorder? A pilot study	Experimental/outcome study (pilot)	III-3	Neuromotor task training Teaching principles: Giving instruction, sharing knowledge, providing or asking for feedback	Significant progress occurred with all students as measured with the [28]M-ABC (p = 0.007) as well as with the [29]TGMD-2 (p = 0.001) The following teaching principles were associated with success: Providing clues on how to perform a task, asking child about a task, explaining why a task should be executed in a certain way.
Valentini NC, Rudisill ME (2004)	Motivational climate, motor skill development, and perceived competence: two studies of developmental delayed kindergarten children	Comparative study Experiment 1: compared the two motivational climates Experiment 2: Mastery climate 6 months follow up.	III-1	Low autonomy group: teacher in authority roll, rigid grouping and duration for activities, public recognition Mastery: Self-paced instruction and pace with tasks, greater variety of tasks, decision making opportunities and private recognition Same activities for both groups: meaningful motor tasks matching children's abilities	Children in both groups made significant progress in locomotor skills and object control skill with the [30]TGMD (p=0.0001). The children in the mastery group made significantly more progress than those in low autonomy group (p = 0.001) The mastery group performed significantly better on long term follow-up assessments for locomotor skills and object control (p= 0.001)
Dankert HL, Davies PL, Gavin WJ (2003)	Occupational therapy effects on visual-motor skills in preschool children	Experimental/outcome study (quasi-experimental, two-factor mixed design)	III-2	Fine motor activities: arts and crafts, finger plays, and small manipulatives Gross motor activities: obstacle course, music, dancing Visual-motor and visual perception activities: drawing, cutting, and assembly	Children with developmental delays and typically developing peers (treatment and control groups) demonstrated significant

[28] M-ABC: Movement Assessment Battery for Children
[29] TGMD-2: Test of Gross Motor Development second edition
[30] TGMD: Test of Gross Motor Development

					improvement in visual motor integration with the [32]VMI scores (p < 0 .0005) Significant progress was also seen with the VMI subtest of visual perception (p <0 .0005) Significant progress with the motor coordination subtest was only seen in the typical development group with treatment (p<0.0005) Planned comparison tests showed that students with developmental delays developed skills at a rate faster than expected when compared to typically developing peers on the VMI
Dreiling DS, Bundy AC (2003)	A comparison of consultative model and direct-indirect intervention with pre-schoolers.	Comparative study (between group design)	III-2	Consultation: therapeutic strategies in the classroom, consultation with teachers and parents Direct treatment: Regular individualised OT programmes	No significant differences were found between the two models (p = 0 .724) Both groups made progress when measured according to goals reached: Consultation group: (Mconsult = 48.25; Mdir.svc = 49.69) at approximately the rate expected (Mexpected = 50; SD = 10)
Goodway D, Crowe H, Ward P (2003)	Effects of motor skill instruction on fundamental motor skill development.	Experimental/outcome study (pre-test-post-test quasi-experimental design)	III-1	Experimental group: SKIP programme: ball skills, galloping, skipping, running, jumping Control group: Normal Kindergarten play	The intervention (SKIP) group presented with significant progress in both locomotor skills (p<0.001) and object control (p<0.001) as measured with the [32]TGMD-2 The experimental groups' progress was significantly better than the control groups' (p<0.001)
Mandich AD, Polatajko HJ, Macnab JJ, Miller LT (2001)	Treatment of children with developmental coordination disorder: what is the evidence?	Comprehensive survey and review 32 studies included (classification of included studies not available)	III-1	Bottom-up approaches - sensory integration - process orientated treatment - perceptual motor training Top-down approaches -task specific interventions -cognitive approaches (problem solving, cognitive-motor, CO-OP)	All interventions included were considered to be more positive than no input. More evidence available for a top-down approach, however a joint approach was recommended
Case-Smith J (2000)	Effects of occupational therapy services on fine motor and functional performance in preschool children.	Evaluation of service / programme (single group pre/post testing) Descriptive design	IV	Direct intervention through [33]SI, motor/manipulation, self-care and play/peer interaction	The participants made significant gains in all eight measures over the course of the academic year (based on Tukey post hoc analysis)

[31] VMI: Developmental Test of Visual Motor Integration
[32] TGMD-2: Test of Gross Motor Development second edition
[33] SI: Sensory Integration

					Participants who received more occupational therapy sessions improved more in visual motor skills (p = 0.43) and social function (p = 0.44). Play (p = 0.15) and peer interaction (p = 0.13) were the only significant predictors of progress with visual motor integration skills. Parts of the following assessments were used: [34]M-ABC, Sensory Integration and Praxis Test (SIPT), [35]DTVP, [36]PDMS, Draw a person (DAP), Pediatric Evaluation of Disability Inventory (PEDI).
Leemrijse C, Meijer OG, Vermeer A, Adèr HJ, Diemel S (2000)	The efficacy of Le Bon Départ (LBD) and Sensory Integration treatment for children with developmental coordination disorder: a randomized study with six single cases.	Evaluation of service/programme (single subject design with multiple baseline and alternating treatments)	III-3	Baseline condition: Movement games at home [37]LBD: Combination of rhythmic music, geometric shapes and body movements [38]SI : Specific SI principles applied	Significant improvement in motor skills following both treatments (SI and LBD) when measured with the M-ABC (p = 0.003), praxis test (p = 0.059) and visual analogue scales (p = 0.028). The LBD treatment showed significantly more gains with a rhythm test when compared to the SI treatment (p<0.05)
Pless M, Carlsson M, Sundelin C, Persson K. (2000)	Effects of group motor skill intervention on five- to six-year-old children with developmental coordination disorder.	Experimental/outcome study	III-1	Experimental group: Purposeful, joyful functional motor activities e.g. skipping with rope, ball games, obstacle courses, games Regular [39]OT consultations service Control group: Regular OT consultation service	No significant difference between groups Within subjects: (F(1) = 2.007, p = 0.165) Between subjects: (F (1) = 0.402, p = 0.530) Significantly more children in the experimental group (p = 0.001) changed to a different (improved) category on the M-ABC than those in the control group (p = 0.809) with the final assessment.
Case-Smith J, Heaphy T, Marr D, Galvin B, Koch V, Ellis MG, et al (1998)	Fine motor and functional performance outcomes in preschool children	Comparative study (quasi-experimental design)	III-2	Regular individualised OT programmes: Visio-motor and manipulation activities Sensory integration activities Consultation	The group without fine motor difficulties made significant gains in the following areas (Tukey's post hoc analysis): In-hand manipulation, manual form perception, visual perception, draw a person, visual motor integration, functional skills, and self-care.

[34] M-ABC: Movement Assessment Battery for Children
[35] DTVP: Developmental Test of Visual Perception
[36] PDMS: Peabody Developmental Motor Scales
[37] LBD: Le Bon Départ
[38] SI: Sensory Integration
[39] OT: Occupational Therapy

					The group with fine motor difficulties made significant gains in the following areas: In-hand manipulation, manual form perception, motor accuracy, visual perception, draw a person, Peabody fine motor scales, visual motor integration, functional skills, self-care. Children who received therapy input made significant ly more progress in the following areas: in-hand manipulation, motor accuracy, draw a person, Peabody fine motor scale, functional skills (p<0.05)
Baker BJ, Cole KN, Harris SR (1998)	Cognitive referencing as a method of [40]OT/[41]PT triage for young children.	Comparative study (between group comparison)	III-2	Goal orientated occupational therapy and physiotherapy Consultation Monitoring	Significant improvements in gross and fine motor skills for both groups were made (p< 0.025) when measured with the [42]PMDS. No correlation was found between fine motor gains and Intelligence Quotient (IQ) (p = 0.095) or gross motor skills and IQ (p = 0.020)
Rintala I, Pienimaki K, Ahonen T, Kooistra L (1998)	The effects of a psychomotor training program on motor skill development in children with developmental language disorders.	Comparative study	III-2	Psychomotor training: Circuit activities including running, climbing on ladder, jumping on trampoline, rhythmic floor jumping, skipping with rope, ball activities, balancing tasks. Body awareness through the Sherborne development movement method PE: Games and sports	Both groups showed significant improvement over time with scores on the [43]M-ABC and [44]TGMD (p<0.001) Children in the psychomotor training group improved significantly more in object control (TGMD) (p= 0.034) and ball skills with the M-ABC (p=0.09) than children who attended regular [45]PE.
Parush S, Hahn-Markowitz J (1997)	A comparison of two group settings for treatment in promoting perceptual-motor function of learning disabled children	Comparative study (Quasi-experimental)	III-2	Gross motor: simulated playground with equipment to facilitate perceptual motor training activities e.g. crawling, climbing, balancing Fine motor: quiet room with table top activities such as puzzles, pegboards, block	The two groups were equivalent in making positive perceptual-motor gains, with no significant difference between results on eight areas tested (p>0.05). Instruments used for measurements: [46]BOTMP, [47]VMI, Motor Free Visual

[40] OT: Occupational Therapy
[41] PT: Physiotherapy
[42] PDMS: Peabody Developmental Motor Scales
[43] M-ABC: Movement Assessment Battery for Children
[44] TGMD: Test of Gross Motor Development
[45] PE: Physical Education
[46] BOTMP: Bruininks– Oseretsky Test of Motor Proficiency
[47] VMI: Developmental Test of Visual Motor Integration

				design, drawing and scissor tasks and creative tasks	perception Test (MVPT), [48]DAP, Loewenstein Occupational therapy Cognitive assessment (Constructional Praxis subtest), Pediatric Examination of Educational Readiness (spatial directions subtest), Basic Motor Ability Test (bead stringing).
Case-Smith J (1996)	Fine motor outcomes in preschool children Who Receive Occupational Therapy Services	Experimental/outcome study(single group pre/post testing)	III-3	Finger painting on vertical surfaces, finding small objects in resistive materials such as play clay, using magnetic wands to pick up small metal objects, or creating animals from pipe cleaners or other textured materials, use of tweezers, eye droppers, or small tongs to stimulate tool use, adaptation of classroom activities to fit with OT goals	Significant improvement of motor function: in-hand manipulation, tool use and eye-hand coordination (p < 0.005) (peg rotation test, [49]SIPT, pencil grasp – developmental progression (dp), scissors grasp (dp), bulb dynamometer) Significant improvement of functional skills as measured with the [50]PEDI (4 subtests: p < 0.0; 2 subtests: p < 0.5).
Davies PL, Gavin WJ (1994)	Comparison of individual and group/consultation treatment methods for preschool children with developmental delays	Comparative study (Quasi-experimental)	III-3	Individual sessions: Occupational therapy and physical therapy treatment using a sensory integration and neurodevelopmental approach Group sessions: Occupational therapy and physiotherapy group sessions using a sensory integration and neurodevelopmental approach	Both groups were equivalent in making significant progress in gross and fine motor skills when measured with the[51] PDMS (p < 0.01) as well as the [52]VABS (p = 0.001) There were no statistical significant differences between the two groups as measured with the PDMS and VABS
De Gangi A, Wietlisbach S, Goodin M, Scheiner N (1993)	A comparison of structured sensorimotor therapy and child-centered activity in the treatment of preschool children with sensorimotor problems	Comparative study (A-B cross-over design)	III-2	Both groups received 8 weeks of an intervention, a retest and the followed up by 8 weeks of the other intervention interventions: Sensorimotor intervention: Therapists used specific handling techniques, exercises, skill training and therapeutic activities Child centered activity: The child initiates all play, the therapist acts as observer and facilitator. Toys and activities that promote sensorimotor development are made available in a safe environment	All children receiving structured sensorimotor therapy showed significant progress in number of months gained with gross motor skills (p = 0.016) and functional skills (p = 0.05) as measured with the PDMS

[48] DAP: Draw-a-person
[49] SIPT: Sensory Integration and Praxis Test
[50] Pedi: Pediatric Evaluation of Disability Inventory
[51] PDMS: Peabody Developmental Motor Scales
[52] VABS: Vineland Adaptive behaviour Scales

TABLE 2-A2: Hierarchy of evidence (Merlin, Weston and Tooher, 2009).

Level of evidence	Study design
I	Evidence obtained from a systematic review of all relevant randomised controlled trials
II	Evidence obtained from at least one properly-designed randomised controlled trial
III-1	Evidence obtained from well-designed pseudorandomised controlled trials (alternate allocation or some other method)
III-2	Evidence obtained from comparative studies (including systematic reviews of such studies) with concurrent controls and allocation not randomised, cohort studies, case-control studies, or interrupted time series with a control group
III-3	Evidence obtained from comparative studies with historical control, two or more single arm studies, or interrupted time series without a parallel control group
IV	Evidence obtained from case series, either post-test or pre-test/post-test

Conclusions and Implications of the Scoping Review

The scoping review maps out common features of interventions identified in the included records as a framework for intervention planning. It is not prescriptive, but rather informative and proposes consideration of approaches, therapy providers, therapy venues, activities, timing and frequency of intervention and individual vs group input when developing a motor skill intervention. At the same time, available resources, and the environment and location of the children in need of intervention need to be considered.

From the results, the conclusion can be drawn that occupational therapists and physiotherapists most frequently facilitate motor skill intervention, although kinesiologists and teachers are also often involved. Group and/or individual treatment intervention may be feasible. The analysis revealed 15 different approaches with varied dosage parameters. Considering the context of a low LMIC such as South Africa, with varied and often undiagnosed conditions causing motor impairment (Camden et al., 2015), the researcher initiated consideration of an eclectic approach at this stage (Ikiugu & Smallfield, 2011). The scoping review thus formed part of the development of an evidence base with regards to preferred approaches, content and structure of an intervention for pre-school children on which to build in order to develop an intervention for children with motor skill impairment on the West Coast and areas with a similar socio-economic background (Skivington et al., 2018).

Forty-five records were included in the scoping review, indicating a high quantity of studies describing a motor skill intervention for pre-school children with motor impairment. Very few studies, however, qualified as true randomised control trials or systematic reviews thereof (according to the National Health and Medical Research Council (NHMRC) hierarchy of evidence) (Merlin et al., 2009). Of these 45 studies, only two were conducted in low socio-economic areas (Ferguson et al., 2013; Najafabadi et al., 2018).

Ferguson et al.'s (2013) study compared the efficacy of two task-orientated interventions for children with DCD (6–10 years) from three schools within a low-income community in Cape Town. The focus of the intervention was on school-going children from grade 1 onwards, rather than pre-school children. A pragmatic single blinded quasi-experimental design was used to compare the effect of either a Neuromotor Task Training (NTT) programme at two schools and participating in Wii Fit gaming at another school. Measures included motor skill proficiency using the MABC-2, functional strength using the Functional Strength Measure

(FSM), isometric strength with a handheld dynamometer and aerobic and anaerobic capacity with a muscle power sprint test and metre shuttle run test. Assessments were performed pre- and post-intervention. Results showed that only the NTT group significantly improved on the MABC-2 total standard score, total FMS score and aerobic and anaerobic performances. In addition to the statistical results indicating that Wii Fit gaming may not be as effective an intervention as other NTT programmes, the difficulties described by Ferguson et al. (2013) in randomisation due to individual schools' difficulties with power supply, highlights the unique difficulties of poor resourced schools in low income areas that may affect implementation of such programmes (Ferguson et al., 2013).

Najafabadi et al.'s study (2018) aimed to determine the effect of the Sports, Play and Active Recreation for Kids (SPARK) programme on 28 Iranian children with a diagnosis of autism. The BOTMP was used to assess motor skills at baseline, pre-intervention and post-intervention of two randomised groups, and results showed that the programme significantly improved balance and bilateral coordination skills of the children in the control group. Although participants' ages ranged from pre-school age (five years) to 12 years, again the study was not directed specifically at pre-school children. The SPARK programme, originally designed to promote physical activity in a school environment rather than addressing motor impairment, however shows promising results for group intervention through playful activities. The programme was delivered by trained coaches in an indoor centre and required specific resources and training (Najafabadi et al., 2018).

Due to the lack of strong evidence-based records and studies related to low socio-economic areas, further investigation was indicated to determine what the recommended guidelines for and components of motor skill intervention would be for pre-school children in rural and poor resourced areas. According to Levac et al. (2010), the final stage of a scoping review is the consultation phase, which is optional, yet recommended. For this project, a Delphi study would draw on expert opinion and include international participants as well as participants with experience of working in low socio-economic areas as a consultation phase. As a complex intervention, this would further model the information and theory base from the scoping review to be more specific to a certain area and community's needs.

An added feature of the scoping review is a list of statements as a statement box. The statement box (van der Walt et al., 2020a) contains important additional information from included records which were not otherwise charted or captured in the analysis. The

statements are categorised under the headings of therapeutic input, interpersonal/social approaches and components of therapy input. It provides information about the importance of intervention, specific elements of treatment and interpersonal/social approaches as well as added information about specific important components of interventions. This information further helped to guide the questions for the Delphi study. Together with the findings of the prevalence study and scoping review analysis, the statement information formed part of a theoretical base for the development of the Hopscotch programme (Cathain et al., 2019).

All records considered for, and included in, the scoping review were saved in the Mendeley online database (Elsevier, 2020) and were used as a data and information source throughout the study. Snowballing and pearling (Hadfield, 2019) were applied to extend the database ongoing as the study progressed. As such, the scoping review can also be seen as a fluid and progressive literature review for the complete study of complex intervention development (Craig et al., 2019).

SECTION 4

DELPHI STUDY: KEY COMPONENETS OF A MOTOR SKILL INTERVENTION DESIGN FOR GRADE R CHILDREN IN THE RURAL WEST COAST OF SOUTH AFRICA

Chapter 4

Introduction

The Delphi study presented in this chapter is a consultation stage following a scoping review (Arksey & O'Malley, 2005; Levac et al., 2010). Levac et al. (2010) describe this consultation stage as a way of deciphering the outcomes from a review, and to develop strategies with stakeholders in the field as findings are transferred to a functional cause. The Delphi study is also the modelling phase of the complex intervention development, as it draws from the theory base developed through the scoping review to refine intervention guidelines for the specific area (Skivington et al., 2018).

Delphi studies are used to systematically build expert consensus (van der Steen et al., 2014). This is done through a series of structured questionnaires and rounds (Boulkedid et al., 2011). A Delphi study enabled the researcher to include experts internationally and nationally over the different regions of South Africa by e-mail. This method was particularly useful during the 2020 COVID-19 lockdown, which would complicate other consensus methods such as the nominal group technique or a consensus conference while gatherings were discouraged or prohibited (South African Government, 2020). The aim of this Delphi study was for participants to consider the summarised information from the scoping review, to determine the specific components to consider when developing a motor skill intervention programme for the West Coast of South Africa through means of expert consensus. These guidelines would, however, be transferable to other rural areas or countries with a similar socio-economic status.

The Delphi study is presented as a paper, ready for submission to *Occupational Therapy International*. This an open-access journal (impact factor = 0.709) with an interest for occupational practice throughout the world (John Wiley & Sons, 2021). The focus of this paper is thought to be of international occupational therapy interest. It demonstrates the methodology of a Delphi study used in complex intervention development, while focussing on accessible motor skill intervention for children who would not have access to intervention due to socio-economic and geographical limitation.

The paper was previously submitted to the journal, *Disability and Rehabilitation* (impact factor 2.222) as it was felt it fitted the scope of rehabilitation procedures for motor skill impairment as a hidden disability (Taylor & Francis, 2021a), and subsequently to the *Early*

Childhood Education Journal (impact factor = 1.135), considered due to the journal's interest in publishing practices in young childhood (Springer, 2021). However, surprisingly, feedback from the editors indicated the paper did not fall into the scope of these journals.

Documents and information related to the planning and implementation of the Delphi study can be viewed as follows:

- Introduction/Invitation letter with consent sent via email to participants: Appendix 16: Delphi study invitation and consent (email)
- HREC ethics approval letter following lapse in ethics approval: Appendix 17: Ethics approval letter following lapse in ethics approval
- Re-consent letter to participants: Appendix 18: Re-consent letter to Delphi participants (email)
- Delphi study questionnaires rounds 1–3: Appendices 19–21Appendix 19: Delphi study first round survey; Appendix 20: Delphi study second round survey; Appendix 21: Delphi study third round survey

The MS Excel data worksheets can be accessed at

https://stellenbosch-my.sharepoint.com/personal/17390885_sun_ac_za/_layouts/15/Doc.aspx?OR=teams&action=edit&sourcedoc={B61969AE-CFC5-4E52-B84E-5637583D6070}

https://stellenbosch-my.sharepoint.com/personal/17390885_sun_ac_za/_layouts/15/Doc.aspx?OR=teams&action=edit&sourcedoc={65626929-9A2B-4B19-B70B-6C8EE58FDD12}

Paper 3: A Delphi study to determine the key-components for motor skill intervention for grade R children in a low-income rural setting in South Africa

Article Cover Page

The following article was written in preparation for submission to *Occupational Therapy International*.

The researcher followed all requirements as prescribed by *Occupational Therapy International*. These instructions prescribe, for example, the length of the abstract and the total manuscript as well as the referencing style to be used. The author guidelines can be viewed at https://www.hindawi.com/journals/oti/guidelines/

However, in order to provide a better insight into the data and improve readability of the dissertation, the following adaptations to the *Occupational Therapy International*

author guidelines were accepted in the article manuscript:

- Details of authors and ethics committee are not blinded in the manuscript
- The tables are inserted in the manuscript for readability purposes
- Line numbers were not included

Designing a motor skill intervention for pre-school children in a low-income rural setting in South Africa: A Delphi study

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Abstract

There is a high prevalence of motor skill impairment among pre-school children in rural low socio-economic areas. While therapy input is paramount, resources are limited. This Delphi study aims to determine what the components would be of a feasible, cost effective motor skill intervention for pre-school children in a rural, low socio-economic area of South Africa.

A three-round Delphi study was conducted with experts in the field, including therapists, kinderkineticists and teachers. The first round investigated demographic details of participants and agreement of participants on role players, structure and content of an intervention. Subsequent rounds' questions followed up on participants' comments and areas of dissent. Agreement was calculated at 75% or mean >4.

Outcomes suggest that a school-based, small-group programme, facilitated by the teaching team, but with clear guidelines, support and advice from therapists should be feasible in a low-income rural context. Inclusivity of intervention groups and aim-formulation proved to be controversial issues that need further investigation.

The results from this study helped develop a guide for motor skill intervention for pre-school children in low socio-economic and rural areas.

Introduction

Children in low- and middle-income countries (LMIC) are known to be at risk of experiencing motor skill delays or difficulties (Pienaar et al., 2014; Valentini et al., 2015) which may affect academic, social and independence skills needed to learn and function in a school environment (Chung, 2018; Harrowell et al., 2018; Roebers et al., 2014). A prevalence study conducted among pre-school children living along the West Coast of South Africa supports these findings (van der Walt et al., 2020b). This region has many challenges, including high levels of unemployment and poverty, and low levels of education in the community (Western Cape Government, 2016). Children with motor skill impairment can, however, benefit from therapeutic intervention and improve these skills (Schoemaker & Smits-Engelsman, 2015). Two recent systematic reviews (Preston et al., 2017; Tanner et al., 2020) and two scoping reviews (Camden et al., 2015; Van der Walt et al., 2020a) identify a wide range of effective motor skill interventions. Unfortunately, the challenge we face in LMIC is *how* to implement best practice with limited resources and community barriers.

Camden et al. (2015), in their scoping review, report that efficient organisation of services is needed to comprehensively address the needs of children with motor skill difficulties. This is difficult in rural settings where therapy services are thinly spread, and therapy input limited due to time, distance, space and other resource constraints (Bateman, 2012; Prakash et al., 2014; Roots et al., 2014; Sonday et al., 2012). Where private services are available, these are usually mostly limited to urban areas and inaccessible to many due to cost and practical issues such as lack of transport (Narain & Mathye, 2019; Ned et al., 2020). Schools in rural settings, furthermore, face many challenges. Teaching staff often need to cope with limited access to teaching aids and information, exacerbated by inconsistent electricity supply. Similarly, the school buildings are often dilapidated (van der Walt et al., 2020b). Parents in rural areas are in many cases less educated and less able to recognise or help children with scholastic difficulty or other challenges they may experience (Chakaninka et al., 2012). The result is that many children with motor skill difficulties proceed through the grades without being recognised by teachers or parents, or receiving much needed therapy input (Missiuna et al., 2012). These barriers are restricting children in benefitting from therapeutic and research advances in LMIC and rural regions, and many children with motor skill difficulties remain undiagnosed and untreated. This is a particular concern for children in their final year of pre-school (grade R in South Africa) as school readiness may be affected (Erasmus et al., 2016; Pienaar et al., 2014).

Van der Walt et al. (2020a) suggest a framework of key components to consider when developing interventions to address motor difficulties in pre-school children. The framework suggests that therapy approaches, role players, service delivery models, venues, structures, and therapeutic activities are considered against available resources as well as location and environmental opportunities and constraints. However, only two studies included in that scoping review were from LMIC, with only one study from South Africa. Further research was needed to investigate how the findings of the scoping review relate to rural low socio-economic areas. Scoping reviews are often used to gather evidence from rigorously conducted empirical studies when developing a programme. However, when the research is not specific enough, the opinion and input of experts are recommended (Benninger & Savahl, 2017; Diamond et al., 2014; van der Steen et al., 2014).

This Delphi study invited experts (including developmental therapists, kinesiologists and teachers) to contribute their knowledge, views and expertise to ensure evidence-based quality intervention, while also considering the needs and challenges of a specific rural community.

Materials and Methods

The method, as described according to the guidelines on Conducting and REporting DElphi Studies (CREDES) (Jünger et al., 2017) and guidelines by Day and Bobeva (2005), informed this Delphi process.

Aims and Objectives

The aim of this Delphi study was to determine the components of a motor skill intervention suitable and feasible for grade R children in a rural low socio-economic area of South Africa. We used the outcomes from a scoping review (Van der Walt et al., 2020a) to determine *who* should participate in the programme; *the key role players* with regards to the management and facilitation of the programme; the *approaches and methods* to be used, and the *logistics to administer* the programme.

Planning Phase

The planning phase involved the formulation of the study aims and objectives aligned to the components identified in the scoping review (Van der Walt et al., 2020a). Criteria for the selection of participants were determined, as well as the design of the questionnaire for round one. Introductory letters were also drafted, to explain the aims of the study, the demographic

and socio-economic characteristics of the specific area involved, and a summary of the results of the scoping review. Pilot studies prior to each round were conducted to ensure readability and comprehensiveness of questions and/or statements, and to determine the time needed to complete the questionnaire.

To be included as a Delphi panellist, experts had to comply with the following criteria: Individual participants had to have a postgraduate degree and/or have published research in a peer-reviewed journal and/or have ten or more years' experience in their field of work. Participants were recruited internationally, however those participants located in South Africa had to represent all regions in both urban and rural areas. All participants had to represent different fields of practice including education, research and clinical practice. These experts represented various professions including occupational therapy, physiotherapy, teachers (with or without physical education (PE) experience), and kinesiologists/kinderkineticists (Van der Walt et al., 2020a). Participants were identified through collaboration between researchers, internet searchers and suggestions from possible participants who were contacted via email. A total of 123 potential participants were contacted for the first round. A minimum of ten participants, including two international contacts for each named profession were invited to participate. For each following round, only those participants who completed the survey of the current round would be included.

The survey platform Checkbox 6 (Checkbox survey Inc, 2020) was used to compile the initial questionnaire (Appendices 19 – 21). Checkboxes, dropdown lists, and Likert scale grading were used to facilitate answering of these questions. Open-ended questions were also included to allow for additional comments and views. Round 2 and next rounds would be developed according to responses in the previous rounds. It was envisaged that for each round, a summary of statements would be drafted for participants to refer to for completion of the next round.

For each round, invitations were sent out to participants via email through the Checkbox server. Consent was required to participate and was explained according to the guidelines of our Health Research Ethics Committee (S16/10/190).

Consensus was conceptualised using percentages for multiple choice and direct input questions, and mean values for Likert scale questions as a statistical rating scale. The cut off for consensus was 75%, indicated as the mean for consensus agreement in a systematic

review of Delphi studies (Diamond et al., 2014); and a mean of >4 on Likert scale grading, based on similar healthcare intervention development Delphi studies (van der Steen et al., 2014). All comments from open-ended questions were listed and categorised on a custom designed MS Excel spreadsheet. We developed a grading system to establish the relevance of each comment to the aim of the study. The grading system ranked comments from a 5 (significantly contributes to knowledgebase of research/very relevant to outcomes of the study) to a 1 (irrelevant information). Only comments graded on a level 4 or 5 would be listed (Table 4.1).

We planned to conduct as many rounds as was needed to reach consensus on the essential elements to be considered for developing a motor skills intervention within the constraints of a rural LMIC setting. The criteria for dropping items in each Delphi round was that consensus (75% or mean >4) was reached.

Round 1

The first Delphi round included 34 questions in three sections. The initial nine questions of the survey collected demographic information from participants. Five checklists determined participants' field of occupation, highest qualification, work setting, publication record and their experience with different diagnoses related to motor skills impairment. The questions regarding age, years of experience and country of work required data entering by participants. Information was captured onto a custom MS Excel worksheet, categorised and labelled. Descriptive statistics were used to analyse demographic data. An open-ended question invited participants to add information about themselves which may be relevant to the study. The comments were listed, categorised and graded (Table 4.1).

The next section collated information on role players, format and content of the intervention. The first introductory question asked participants to grade their agreement on the following question on a 5-point Likert scale: "***Some form of therapeutic intervention is essential to improve the motor skills of children who have significant motor skill difficulties***". The mean and percentage of agreement was calculated. The next four questions asked participants to rank named role players according to the most appropriate person as facilitator of the intervention, advisor to the facilitators, support worker or assistant to the facilitator and overall, most important role player of all. The named options as role players to allocate to the different roles were occupational therapists, physiotherapists, kinesiologists, teachers with PE

experience, class teachers and teaching assistants. The percentages according to ranked place values were calculated to determine the first three highest graded role players.

Then eight dropdown lists and checklists gave options regarding the format of the intervention. This included group vs individual treatment, treatment venue, which children to include when working in groups in a school environment, when in a school year to start an intervention, understanding of a child-centred approach, preferred therapy approaches, and activities to include. Percentages were calculated to measure levels of agreement. Four questions required direct numeric data input, where participants were asked to provide recommendations regarding group size and time length of sessions, programme duration and intervention frequency. For these, data were grouped together in intervals and percentages of agreement were calculated. Six open-ended questions allowed participants to comment on their chosen answers with a final section for any further comments or suggestions. As in the first section, comments were listed, categorised and graded, as presented in Table 4.1

Table 4.1: Delphi study participants' comments according to category and frequency

Round - section	Survey section topic	Total comments in section	Common statements by categorisation	(n) participant comments per statement
1 - 1	Any comments – end of demographics section	14	Children do not play enough	1
1 - 2	Therapy input is essential – comments	23	Early intervention promotes school readiness and school performance	9
			Therapy is essential but can take on different forms	4
			Research suggests that therapy input is essential for children with motor skill impairment	2
			Children regress without therapy input	1
			Well graded therapeutic input is important to avoid splinter skills	1
			Therapy intervention improves quality of life and decreases learning difficulties	1
1 - 3	Group or individual input – comments	24	The decision to use individual or group sessions depends on the child's diagnosis and level of difficulty	7
			It depends on available resources	4
			Individual and group treatment both have their own unique advantages	4
			It may be beneficial to start off with individual treatment and progress to group treatment	3
			Positive peer pressure and the opportunity to copy peers can be beneficial in a group setting	2

Round - section	Survey section topic	Total comments in section	Common statements by categorisation	(n) participant comments per statement
			A combination of individual and group treatment is the preferred option	1
			A small group seems preferable to address specific difficulties while being cost affective	1
			All children should be included in a group to stimulate optimal development, however, children with specific difficulties may need specialised intervention	1
			Care should be given to ensure individual children's participation in groups	1
1 - 3	Grouping of children – comments	19	All grade R children will benefit and positive peer support may be beneficial	4
			All children should be included but children with difficulties should receive extra input	2
			Singling out children with difficulties as a separated group may label them	2
			Different models may work, depending on resources and class structure	2
			In an inclusive group, children who do not have difficulties may be bored and children with difficulties will stand out more	1
			The intervention should be purely need-based	1
			Integrated groups create a sense of belonging	1
			To maximise use of resources include only those with difficulties and provide teacher training to address general motor skill development for rest of the class	1
			Children with difficulties should be grouped together so that they can perform at their own level without feeling judged	1
			All children should be grouped together, but using different strategies for those with difficulties	1
1 - 3	Intervention aimed at improving gross motor skills or both gross and fine motor skills – comments	22	Both are interrelated and important for school readiness	11
			Skills are transferable	2
			Both should be included according to the goals of a session	1
			Gross motor skills precede fine motor skills and should be addressed first	1
			Variety between gross and fine motor tasks allow for a variety of experiences of mastery	1
			Gross motor skills precede fine motor skills, however, grade R children need fine motor skill development in preparation for grade 1	1
			Intervention should be task-specific	1
			Addressing both skill sets are essential as skills are not automatically transferred	1

Round - section	Survey section topic	Total comments in section	Common statements by categorisation	(n) participant comments per statement
			Both, but 80% gross motor and 20% fine motor	1
1 - 3	Activities to include – comments	22	Equipment and materials should be affordable, easily available, safe, non-toxic and locally appropriate	3
			Activities that promote motor skills can also form part of the daily general activities at school	3
			A variety of activities will keep children motivated and excited	3
			There should be sufficient equipment available to promote physical activity	2
			Specialised therapy equipment is not necessary	2
			Activities should be meaningful to the child	1
			Activities should offer a range of sensory and motor experience that extends and challenges their existing performance	1
			Activities should be perceived as fun	1
1 - 3	Any further comments or suggestions – end of round one	9	There needs to be more collaboration between the public sectors especially education and health to employ therapists to assist with early intervention programmes like these	1
			Accessibility for all children in the community is essential with regards to the design, implementation, monitoring and evaluation of a programme	1
			Diagnosis of difficulties is important to ensure the correct focus of a programme	1
			The facilitators should receive adequate training	1
			Individual evaluation or screening is essential prior to group intervention	1
2 - 1	Individual vs group intervention in context of West Coast – comments	5	Proper individual evaluation or screening is essential prior to a group intervention	1
			Group sessions are largely cost effective and lend themselves to the inclusion of play more easily	1
2 - 1	Role players – comments	8	The role players will depend on the specific needs of the children in the group	1
			Sufficient training needs to be provided by experienced professional OTs and PTs	1
3 - 1	Final comments or recommendations	8	The ideal would be to include all the children in the intervention programme, but practical issues, e.g., class sizes and lack of enough professionals to work with the children, prohibit this. Second best is therefore to include only children with significant difficulties.	1
			Research supports targeted group intervention for children with similar abilities	1
			Early identification of difficulties is important	1

Round - section	Survey section topic	Total comments in section	Common statements by categorisation	(n) participant comments per statement
			Children with difficulties should be grouped together, but the other children should also be included in the programme in a separate group – is essential that "no child is left behind" or falls through the cracks	1

Round 2

The second round of the survey consisted of 12 questions. The outcomes of the first round were presented to the participants as an introduction to the second round in their email invitation. Three questions followed up on participants' comments or previous questions – these included a question about methods to identify children who would benefit from the programme by choosing one or more of eight options aimed at early identification of motor skill difficulties. Participants were also asked to suggest possible screening tools in an open-ended question. A question about how therapy aims should be determined was added, giving participants a choice between general developmental aims, aims specific to a group of children or aims specific to each child. The issue of group vs individual sessions was depicted further in this round within the specific context of a rural low socio-economic area.

The aspects where consensus was not reached (<75%) in round 1 were regarding **who** to include in an intervention group, and the session duration. Supportive information was added where appropriate. For example, to determine the time length of a therapy session, the question was formatted as follow: "***Participants agreed on an 8- to 12-week programme (roughly 2 terms) with 2 sessions per week. Considering that the children in the group will be aged 5 – 7 years and that the sessions will take place during school hours, how long do you think each session should be? Choose one option***". These five questions were formatted as checklists and calculated by percentage to determine consensus. Three questions followed up on role-players. For these, participants were asked to rank their agreement with the following statement on a 5-point Likert scale: "***Considering the vastness of the West Coast area and limited resources, this role could be played by any one of the above-mentioned role players according to availability and experience***". For each role (facilitator, advisor and assistant), the question provided the three options with the highest score from the previous round. The mean was calculated to determine consensus and can be seen in Table 4.2. Four

open-ended questions gave the option for further comments or suggestions. The comments and suggestions were listed, categorised and graded.

Table 4.2: Agreement on intervention roles – round 2

Question	Percentage agreement >4 on 5-point Likert scale	Mean (SD)
The role of a facilitator could be played by any one of the above mentioned role players according to availability and experience: Teacher with physical education experience, Occupational Therapist, Physiotherapist	95	4.5 (0.72)
The role of an assistant could be played by any one of the above mentioned role players according to availability and experience: Teacher with physical education experience, teaching assistant, class teacher	91	4.36 (1.02)
The role of an advisor could be played by any one of the above mentioned role players according to availability and experience: Occupational Therapist, Physiotherapist, Kinderkineticist	82	4.18 (1.19)

Round 3

The final round consisted of three questions. The results from both previous rounds were summarised as an introduction to the invitation email. Two questions were repeated from the second round as consensus was not reached, but with the following supportive information: "***The West Coast of SA is a vast area with 97 government primary schools with grade R classes. The number of grade R learners per school varies from 7 to 150. Survey participants agreed that a motor skill intervention group should consist of 5 - 8 learners***". Questions about **who** to include in a therapy group and **how to determine therapy aims** were repeated as checklists. Percentages were calculated to determine consensus. The final question was open-ended and invited participants to contribute any further comments or suggestions. These questions were analysed as in previous rounds.

Results

Participant Characteristics

Twenty-nine experts participated in the first round of the study with demographic details presented in Table 4.3. Nine participants worked in the field of physiotherapy, seven in occupational therapy, seven in education and six in kinderkinetics. Twenty-five participants (85%) had a postgraduate qualification, while eighteen (72%) had published at least one article in a peer-reviewed journal. Participants had an average of 20 years' experience (range

5 – 50). Countries of practice included South Africa (24), United Kingdom (2), Madagascar (1) and Australia (1). Six participants lived and worked on the West Coast of South Africa at the time they completed the questionnaire. Work settings varied between schools (15), public health sector (3), private sector (8), community (1) and university settings (17), with some working in more than one setting. Experience with regards to diagnoses varied, but main areas of experience were with children with Attention Deficit and Hyperactivity Disorder (ADHD), dyspraxia/Developmental Coordination Disorder (DCD), autism spectrum disorders (ASD) and motor skill difficulties not specified by diagnosis.

Table 4.3: Demographic details of Delphi participants in round 1

Demographic category	Frequency (N = 29)	Percentage
Age		
30 - 40	12	41
41 - 50	11	38
51 - 60	4	14
60 +	2	7
Country of residence		
South Africa	25	86
United Kingdom	2	7
Australia	1	3.5
Madagascar	1	3.5
Work setting (one or more)		
School	15	52
Public health sector	3	10
Private sector	8	28
Community	1	3.5
University	17	59
Qualification		
Graduate	4	14
Honours degree	4	14
Master's degree	10	34
PhD	11	38
Years of relevant experience		
5 - 10	4	14
11 - 25	17	58
26 - 35	6	21
36 - 45	1	3.5
45+	1	3.5
Field of practice		
Physiotherapy	9	31
Occupational Therapy	7	24
Kinderkinetics	7	24
Teaching	6	21

Role Players

In the first round, participants were asked to rank the role players in order of perceived overall importance and for the position of facilitator, assistant and advisor. The percentages of highest-ranking role players were scattered and agreement at 75% was not reached for any of the four role-player questions.

The second round focussed on the three most highly ranked disciplines from round one for each role – facilitator, assistant and advisor – and requested participants to rate their agreement with three statements on a 5-point Likert scale, while considering the vastness of the named rural area and limited resources.

The study found that the role of facilitator could be played by teachers with a physical education role, occupational therapists (OTs), or physiotherapists (PTs). The role of assistant could be played by one of three of a school's teaching team. Health professionals (OTs and PTs) and kinderkineticists were recommended as advisors. See Table 4.2

Content of the Intervention

Agreement was reached in all areas concerning the content of an intervention in the first round of the study. It was agreed on that the most important factors of a child-centred approach are that the intervention should take place though means of facilitation rather than teaching (89% consensus), the activities used should be guided by the child's interests (79%), there should be clear boundaries and rules (75%) and that the child should assist with goal setting (75%). The three most frequently chosen approaches were: an indirect approach (including training and advice to facilitators, and feeding into the individual education plan of children) (82%); input through physical education or normal class activity in schools (79%) and a visual-perceptual motor approach (75% consensus). It was agreed on that both gross and fine motor skill activities should be included in an intervention (79% consensus). Activities most frequently chosen to include in a programme were: activities using general PE equipment (96%) or general playground apparatus (96%), obstacle courses (89%); arts and crafts (79%); fine motor games (79%) and sport activities (75%).

In the second round, it was agreed on that a motor skill checklist (77% consensus), with adjacent training (77%), should be available for teachers. Guidance should be given as to which children should be referred for additional therapeutic intervention (91%). Participants suggested several screening tools, including general developmental checklists, the Bruininks–Oseretsky Test of Motor Proficiency (short form), the MABC- 2 checklist, University of Witwatersrand (WITS) developmental profile and Clinical Observations of Gross Motor Items developed by the South African Institute of Sensory Integration. Two participants suggested the Developmental Coordination Disorder Questionnaire (DCDQ). It was also

agreed that a group intervention in schools was the most appropriate option for the West Coast area (82%), with a clear referral pathway for children who need more specialised input.

Format of the Intervention

Consensus was reached for seven of the eight format-aspects of the intervention in the first round. Participants agreed that motor skill intervention for Grade R pre-school children can be carried out as an individual or group intervention (82% consensus). For a group intervention, five to eight children per group was recommended (79%). Intervention can successfully take place in a school setting or at a therapy centre (79%). The preferred time to start a motor skill intervention in a school environment is in the first quarter of a school year (100%). The duration of a programme should be 8 – 12 weeks (86%), with two sessions per week as the preferred frequency of sessions (89%). The time length per session was agreed on as 30 – 45 minutes (93%).

Aspects without Consensus

The two, seemingly interlinked, concepts of who to include in an intervention group and how to determine group aims remained areas of dissent up to the third round. Participants were divided between choosing the option that all grade R children should be included in the intervention, but children with motor skill difficulties should be grouped separately (58%); that all children in the class should be included (23%) or that only children with motor skill difficulties should be included in the intervention (13%). The 7% of participants, who chose the "other" option in the checklist, explained that it depended on the objectives of an intervention and resources available. In the optional open-ended comments section, where participants were asked to explain their answer, they contributed valuable information, which guided the questions in the second round (Table 4.1).

In round 2, the questions were reformatted and a summary of participants' comments was stated as an introduction to the question to help guide participants:

"*Participants agreed that a group should consist of 5 - 8 children, but consensus was not reached on who to include and how to group children together. Please consider the following comments of participants in round one of this study before choosing one of the options. - Integrated groups will avoid stigmatism - Separate groups provide opportunity for practice on each child's own level - Typically developing children may be bored if included - Children*

with difficulties will stand out if everyone is included - Children could be grouped separately according to difficulties at first, but later be merged together as children progress - All children should be included but differentiation of strategies is important - All developing children will benefit and it is a way to identify difficulties."

In this round, results indicate that participants were equally divided between choosing the option of only including children with motor skill difficulties (36.4%) and including all children, but grouping children with motor skill difficulties separately (36.4%), with only slightly fewer participants choosing the option of an all-inclusive intervention group (27%).

For the final round, demographic information of the area was added, related specifically to the questions, with an additional option in the checklist namely: "*Only children with significant motor skill difficulties should be included for a pilot study to test the programme before considering inclusion of the whole class*." Results were as follows: 44% of participants chose to include all children, but group those with motor skill difficulties separately; 33% chose the additional option of a pilot study to help determine the outcome; 17% felt that only children with difficulties should be included, while only 6% still felt that all children should be included.

A question in round 2, which originated from participants' comments from the first round, asked participants to consider the formulation of aims for the intervention programme. Forty-six percent of participants agreed that group aims should be generalised according to developmental milestone; 32% chose the option of group aims, but for the specific children in an intervention group; 18% felt that aims should be individual for each child, while 5% chose the option "other".

The survey was terminated after round 3 because sufficient areas of consensus were reached to develop a programme. Nevertheless, the items of dissent were not disregarded and valuable comments from participants helped to guide the researchers to incorporate the different views into decision-making and further planning. Two comments made by participants can be highlighted as particularly valuable, as they summarise views across all rounds of the study:

"*The ideal would be to include all the children in the intervention programme, but practical issues, e.g., class sizes and lack of enough professionals to work with the children, prohibit*

this. Second best is therefore to include only children with significant difficulties." (Table 4.1 (3 – 1))

and

"*Children with difficulties should be grouped together, but the other children should also be included in the programme in a separate group – it is essential that "no child is left behind" or falls through the cracks.*" (Table 4.1(3 – 1))

Discussion

The results of this Delphi study provide intervention guidelines for a rural, low socio-economic area as agreed by expert participants. Results suggest that a school-based, small-group programme, facilitated by the teaching team, but with clear guidelines, support and advice from therapists should be feasible in a low-income rural context.

All participants in the study are considered to be experts in their fields with an even spread between disciplines, varied experience, fields of practice/work and geographical locations. The wide representation strengthens the depth and scope of shared knowledge as well as the validity of consensus reached. With most participants (83%) living and working in South Africa, of whom six specifically in rural areas, participants were able to draw from their own first-hand experience and knowledge, while international experts brought objective experiences, linked to different contexts, to the study. A limitation to the study was the scope of expertise – experts were selected according to results of a scoping review (Van der Walt et al., 2020a), however valuable information might have been missed from the wider multidisciplinary team, e.g., speech, hearing and language therapists, dieticians, paediatricians, educational psychologists, etc.

This Delphi study suggests professional therapist involvement, but also included teachers and kinderkineticists as role players in a motor skill intervention in schools. It supports current practices that, through close collaboration with teachers, some of the role of therapists can be transferred to the teaching team through indirect interventions such as an advisory approach (Ward et al., 2017; Van der Walt et al., 2020a).

While the main providers of motor skill assessment and intervention are occupational therapists and physiotherapists (Smits-Engelsman et al., 2018), kinderkineticists, as trained professionals in the field of motor skill development, also provide direct intervention through

perceptual-motor programmes (Pienaar et al., 2011), advice and school-based interventions (Erasmus et al., 2016). A study by Bremer and Lloyd (2016) describes a school-based fundamental movement skills (FMS) programme for children with autism-like characteristics, working closely with teachers, resulting in an increased readiness of teachers to teach FMS (Bremer & Lloyd, 2016). Foundation phase teachers (grade R to 3) are educated in life skills, which include physical education (Stellenbosch University, 2020), while Human Movement Studies is an elective subject area for intermediate teacher training (University of Pretoria, 2020). This study area equips teachers with a basic knowledge of movement development, while they are also well equipped to deliver educational programmes to groups of children.

The interchangeability of the three highest ranked role players per role provides opportunity to use existing resources and reduce costs. It promotes community involvement and opens opportunity for task-shifting. This is the process in which non-specialists with little or no prior training or experience provide treatment under supervision (World Health Organization, 2008). The process of task-shifting is well-known as an alternative approach to provide care in rural communities for people living with human immunodeficiency virus **(**HIV) or acquired immunodeficiency syndrome (AIDS) (Dawad & Jobson, 2011). It has also been extended, for example to mental healthcare for children in rural communities: Dorsey et al. (2019) investigated the perceptions of health workers and teachers in a task-shifting mental health intervention for children in Kenya. It was found that both health workers and teachers, as lay counsellors, endorsed acceptability, feasibility and appropriateness of delivering the structured programme (TF-CBT) in their communities. Task-shifting was dependent on existing government supported systems – for children these may include health and education, with delivery by individuals who are already part of this system (Dorsey et al., 2019).

Consensus on components regarding the format of an intervention created a clear structure appropriate for grade R pre-school children in a rural area. A programme that commences in the first term of the school year, thus promotes early identification of possible motor skill difficulties. Early identification is of particular importance in South Africa where school readiness is a concern, especially for disadvantaged children (Sherry & Draper, 2013). Although children in South Africa are only compelled to attend school from ages seven to 15, starting from grade 1 (Republic of South Africa, 1996), a bill to make the two years prior to Grade 1 compulsory was announced in early 2020 (Businesstech, 2020). A motor skill

intervention with early identification of difficulties within these two years prior to formal schooling may improve school readiness (Sherry & Draper 2013; Erasmus et al., 2016).

A key feature of the programme is a valid and reliable tool to screen and identify children with motor skill impairment. Of the screening tools suggested by participants, the Developmental Coordination Disorder Questionnaire (DCDQ) is the only suggested tool that is affordable and reliable and can be administrated by parents or teachers (DCDQ, 2016). The DCDQ has been standardised as a reliable screening tool for motor coordination difficulties among Canadian children aged 5 – 15 years (Wilson et al., 2009). It has been translated into eight other languages and cross-cultural adaptations are supported and have been tested in Japan, India and Italy (Caravale et al., 2014; DCDQ, 2016; Nakai et al., 2011; Patel & Gabbard, 2017). The DCDQ may be a viable possibility to use as a screening tool, however further research on the reliability and validity within the South African population is needed.

The suggested 8 – 12 weeks (approximately two terms) time span of a programme provides adequate time for re-testing and the possibility of further treatment within the grade R school year where required. The four weeks variation provides room for flexibility within individual schools' programmes and should also include training for group facilitators. A small group size as recommended (5 – 8 children maximum) in a group is associated with positive outcomes in motor skill interventions (Smits-Engelsman et al., 2018). The uncertainty around *who* to include in such a group intervention and how to group children together was underpinned by important issues raised by participants. These included issues around inclusion, benefit for all, labelling, equal access and opportunity vs a targeted approach, prioritising in view of limited resources and self-esteem problems among children with difficulties when comparing themselves to their peers. There is evidence to support all-inclusive groups. A study by Valentini and Rudisill (2004) among Brazilian children investigated the effect of an intervention with a specific task-orientated approach, by setting individual aims for each participating child (with or without motor skill impairment) (Valentini & Rudisill, 2004). The opposing comments in our Delphi study opens research opportunities in a country such as South Africa where inclusion is part of educational policy (Republic of South Africa, 1996), to further establish the advantages and disadvantages of inclusive groups.

The approaches agreed on are feasible as part of a school-based programme – a perceptual motor approach can be used to devise a programme to fit in to a school's existing PE

programme (gross motor skills) and classroom schedule (fine motor skills). The therapist in the advisory role will assist by providing training, giving advice and feeding into the individual education plans of children. The programme should be accessible to all and should not be affected by socio-economic circumstances. General PE and playground equipment could be incorporated – this may mean that there would be a minimum requirement for equipment prior to initiating the programme. There are many schools in rural areas of South Africa with very minimal or no playground equipment, which has a significant effect on the development of fine motor skills (van der Walt et al., 2020b). The implementation of basic playground equipment through community involvement could be a long-term asset for schools and for children's motor skill development and could be done through community involvement. A positive example is a project run by the occupational therapy department at the University of Free State in collaboration with local companies, engineering departments and the education department. They developed a project named "Back to Urth playgrounds" (Common Good First, 2020), where recycled materials were used to create cost effective and sustainable playgrounds for children. Their experimental study showed improvements in the motor skills and school readiness of children who had access to such a playground when compared to children who did not (Van Jaarsveld, 2018). Other possible activities to include in a programme were obstacle courses, arts and crafts, fine motor games and sport activities, which are all practical to include in a cost-effective programme.

Conclusion

This Delphi study provides clear guidelines regarding role players, format and content for a motor skill intervention programme for grade R children with motor skill difficulties attending a school in a rural, low-income setting. In addition, the study also provides considerations for developing intervention programmes in other areas.

Two controversial matters concerning individual vs group programme aims and inclusivity of therapy groups are yet to be determined. Further investigation into an appropriate standardised screening tool, valid for use by teachers in South African schools is also necessary.

Data availability

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Conflict of interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Ethics approval

The study was approved by the Stellenbosch University Health Research Ethics Committee in accordance with the ethical standards as laid down in the Declaration of Helsinki.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

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Conclusions and Implications of the Delphi Study

The Delphi study resulted in the guidelines to develop a feasible and cost-effective motor skill intervention programme, specifically for grade R children on the West Coast of South Africa. Agreement was reached in most components of interventions development through the three rounds. A specific area of dissent was the inclusivity of therapy intervention groups. Division occurred between experts on aspects of exclusion, stigmatism, focussed intervention and the role model advantages over the three rounds. Although there is positive evidence for inclusive groups (Ratzon et al., 2009; Valentini & Rudisill, 2004), there appears to be a need for further research studies focussing on this aspect. The flow from the scoping review framework to the guidelines as recommended by the Delphi study is a good example of the progressive fluid process of complex intervention development (Skivington et al., 2018).

The next step in the process of complex intervention development is the final programme development and evaluation planning (Cathain et al., 2019).

SECTION 5

HOPSCOTCH: THE DEVELOPMENT OF AN INTERVENTION PROGRAMME

Section Introduction

The outcomes of the prevalence study, scoping review and Delphi study, existing theories and research advances in motor skill interventions and the proposed framework for developing motor skill interventions (Van der Walt et al., 2020a) informed the development of Hopscotch, a motor skill intervention for grade R children (Cathain et al., 2019). As a school-based intervention, consideration was given to the practical implications of the physical school environments, playground structure and availability, prescribed resources, the educational curriculum and timeframes available. These location, environment and resource filters were informed by local and national policy (Department of Basic Education, 2011b; West Coast District Municipality, 2012; Western Cape Government, 2019), the researcher's own experience of working in various grade R settings in the area, and her experience of visiting schools in different socio-economic and geographical areas during the prevalence study. The process delivered a carefully planned intervention, aimed at being simple in design and execution requirements, yet incorporating all the important recommended principles and components needed to improve motor skill proficiency. The development of the programme and a detailed description of its content are presented in Chapter 5 in this section.

The researcher envisages that the planned follow-up exploratory trial, as described in the protocol manuscript, will evaluate the preliminary effect of the Hopscotch programme and indicate those aspects of the programme that need revision. It will also indicate the feasibility of the intervention. The programme will be facilitated by an occupational therapist for the trial. Once its effect on motor skills and academic progress is established, further testing using a task-shifting approach to teachers is planned.

Chapter 5

Programme Development

Introduction

This chapter describes the planning, development and content of a school-based intervention to improve the motor skills of grade R children in a rural low socio-economic area. The template for intervention description and replication (TiDier checklist) was used (Hoffmann et al., 2014) to ensure all essential details are included. The high prevalence of children with motor skill impairment on the West Coast of South Africa (Van der Walt et al., 2020b) motivated the development of an intervention appropriate for children from a rural and poorly resourced setting. A shortage of developmental occupational therapists and physiotherapists in the area further prompted the decision to adopt a school-based intervention strategy. The high prevalence of manual dexterity (fine motor skills) impairment (24.6%) influenced the content and approach of the intervention (Van der Walt et al., 2020b).

Core components for such an intervention identified through the scoping review (Van der Walt et al., 2020) provided a framework for intervention development. This was reviewed and refined by multidisciplinary field experts in the Delphi study (Van der Walt et al., in preparation) to gear the development of the programme towards a rural, low socio-economic area in South Africa. Table 5.1 illustrates the fluid and progressive development of the Hopscotch programme as a complex intervention in the development phase (Craig et al., 2019). The components of treatment approaches, role players, service delivery models, venue, structure and activities are considered against an overarching theory and policy base, while using the main influencing factors (location, environment and resources) to "filter" the components to the specific cohort. Context specific literature and local policy were added filters which guided the structure and content of the Hopscotch programme.

Table 5.1: The fluid and progressive development of the Hopscotch motor skill programme through the developmental stages of complex intervention development

	Element	Prevalence Study	Scoping Review	Delphi study	Filters	Hopscotch motor skill programme
Research Evidence and Policy	**Main treatment approaches**	Indirect approach through Consultations model aimed at individual cases	Visual Perceptual Motor Sensory Integration Task-Specific Training PE/classroom activities Indirect intervention	Indirect intervention PE/classroom activities Visual Perceptual Motor	**Location** Rurality/accessibility of schools Playground Availability Motor skills deficits of target population	Eclectic approach based on a body-function-activity oriented approach, with visual perceptual motor, sensory integration and task-motor training principles
	Role Players	Two WCED OT posts for region One school employed an OT on governing body funds for grade 1–7 Limited access to private services in area No other role-players involved	Occupational Therapist Physiotherapist Kinesiologist Teacher PE teacher Specialised therapist Parents	Facilitating role: PE teacher, occupational therapist, physiotherapist Assistant role: PE teacher class teacher, teaching assistant Advising role: occupational Therapist, physiotherapist, kinderkineticists	Services available **Environment** Community involvement Socio-economic status Infrastructure of schools **Resources**	Facilitating role: Teacher Assistant role: Teaching assistant/other staff as possible Advising role: OT/PT
	Service delivery model	WCED OTs visit schools on request in consultation role	Comprehensive therapy services Integrated therapy service in school environment Consultation therapy service Supervision of support therapy staff delivering service	School-based, small-group programme, facilitated by the teaching team, but with clear guidelines, support and advice from therapists	Availability of role players in the area Equipment and materials Prescribed resources according to the Grade R life skills curriculum guidelines **Context-Specific Evidence**	School-based, small-group programme, facilitated by the teaching team, but with clear guidelines, support and advice from therapists
	Venue	Private OTs at private clinics Schools	School Therapy centre Home	School	Findings of studies in LMIC	School
	Structure	Private: very limited individual sessions No other programmes	Individual treatment and/or group intervention Length of programme +/- 15 weeks 2 sessions per week Duration of a session +/- 45 min	Small group intervention Length of programme 8–12 weeks 2 sessions per week Duration of a session 30–45 min	**Context-Specific Policy** Grade R curriculum requirements (CAPS) of the SA education department WCED policies and procedures	Small group (up to 8 children) Length of programme 12 weeks 4 weeks training, screening, 8 weeks intervention 2 sessions per week Duration of sessions 45 min
	Therapeutic activities	Unknown Some schools have playgrounds, while others have very limited or no playground equipment	Arts and crafts; Board games; Fine motor games; Indigenous games; PE equipment; Playground apparatus; Sport; Obstacle courses; Worksheets; Classroom tasks, Therapy equipment; Virtual gaming	Activities using general PE equipment or general playground apparatus; obstacle courses; arts and crafts; fine motor games and sport activities	**Clinical reasoning of researcher**	Gross motor sessions: obstacle courses Fine motor sessions: arts and crafts

The Updated Proposed Framework for Intervention Development

The proposed framework of components for intervention development, as developed in the scoping review (Chapter 3), proved valuable and functional, firstly to inform the Delphi study, and subsequently to design the Hopscotch motor skill intervention. Through the process of complex intervention development (Skivington et al., 2018), new concepts and influencing or filtering aspects emerged, which resulted in an updated version of the framework. These concepts include the overarching section of policy and evidence as influencers from the onset of intervention planning. These aspects are also added to the filter, but as context-specific policy and evidence.

This framework follows the Model of Occupation Engagement as described by Hammell & Iwama (2012). In their paper, it is argued that although most occupational therapy models of engagement acknowledges the role of the environment, the focus should be wider than individual issues, especially in LMIC. When considering interventions for a specific area or group, people cannot be separated from their environment and occupational engagement should be considered against environmental issues such as poverty, rurality and social inequities (Hammell & Iwama, 2012). To achieve this, it is important to consider context - specific research evidence and area or institution policies, together with the environment, physical location and resources available when conceptualising an intervention for specific groups.

Figure 5.1 illustrates the updated framework. In this diagram, the specific components related to motor skill intervention for pre-school children were omitted to open the framework to other types of intervention. This framework may assist in any intervention development; however, it was developed for low resourced contexts.

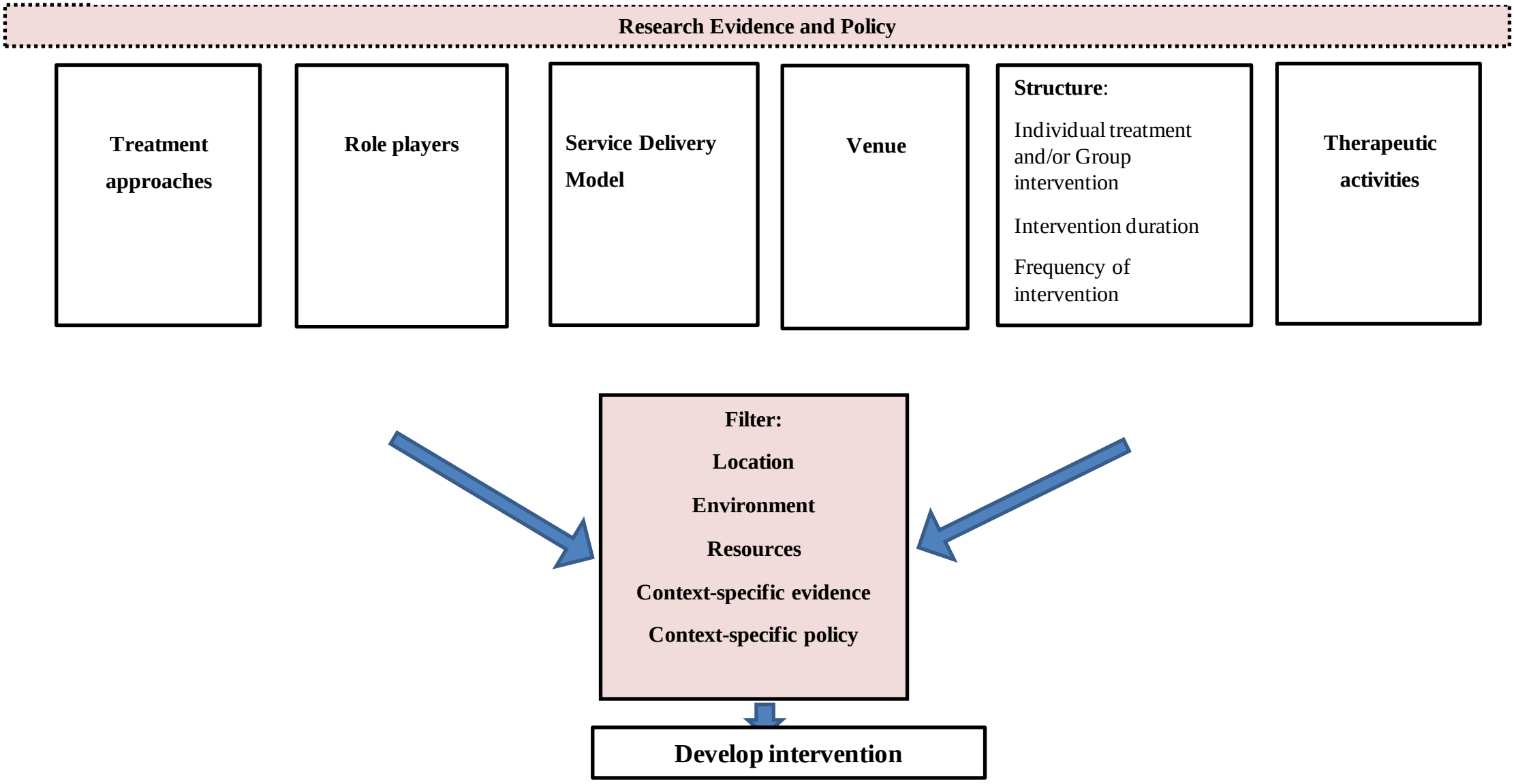

Figure 5.1: An updated framework of components to consider when developing an intervention

Treatment Approaches for Hopscotch

Evidence-based practice is an important principle in motor skill intervention design (Sugden, 2007) and known research-based theories, as described in Section 1, were recognised and considered as important in the development of the intervention. The outcomes of the scoping review (Van der Walt et al., 2020a) indicated that a VPM approach, SI and TST were most often used among the included studies. Delphi study participants agreed on a VPM approach, intervention through usual physical education (PE) and classroom activities, and an indirect approach (training and advice to facilitators) as preferred approaches to use for motor skill intervention in rural low socio-economic areas (Van der Walt et al., in preparation). While a VPM and SI approach fall under the umbrella of general ability approaches (Pless & Carlsson, 2000), TST, and intervention through PE and classroom activities relate to normative function approaches (Bond, 2011; Sugden, 2007b). The latter two approaches, together with an indirect advisory/facilitation approach, indicate a dynamic systems theory thinking pattern, where interaction between the child, his environment and functional tasks at hand are considered (Zwicker & Harris, 2009).

Following on from the informative studies (scoping review and Delphi study) and empirical evidence from studies described, an activity-based body-function oriented approach was adopted for the Hopscotch motor skill programme (Smits-Engelsman et al., 2018). VPM, SI and TST principles are used through functional gross and fine motor play to reach individual functional aims, which will help prepare the child for school-readiness. The proposed approach can also be described as an eclectic approach, as defined by Ikiugu & Smallfield (2011). In Ikiugu's model, therapists use their clinical reasoning to choose the theoretical practice model that best fits their client/s needs – in our case this would be the body-function oriented approach as our organising model of practice (OMP). Task-specific training (TST), VPM and SI principles are included as complementary models of practice (CMP) (Ikiugu & Smallfield, 2011). The key motor skills components targeted by each model of practice, as well as the principles applied, are summarised in Table 5.2.

Table 5.2: The Application of Approaches to the Hopscotch programme

Approach	Definition/aims	Components targeted in the Hopscotch programme	Key principles applied in the Hopscotch programme
Body-function oriented	Therapeutic input aimed at treating specific areas of body-function underlying targeted functional motor problems[1]	Postural tone, bilateral integration, body awareness, fine-motor grasps, eye-hand coordination, hand strength, Static balance, dynamic balance, finger isolation, eye-foot coordination	Structured play and classroom activities are used to address the areas of body-function these young children are still developing in order to improve motor skills competence.
Activity-based	Functional approach where the activity used aims to improve performance in that activity[2]	Confidence, playground agility, early sport participation, pencil skills, scissors skills	Age-appropriate functional activities are used in preparation for school-readiness
Visual Perceptual Motor	The development of gross and fine motor skills in combination with spatial awareness through practice, using age appropriate activities[3]	Motor planning, midline crossing, spatial awareness, eye-hand coordination, static balance, dynamic balance, eye-foot coordination	Activities used target the components of motor skills development which influence functional motor skill competence. Activities allow for the integration of visual-spatial awareness and motor skills.
Sensory Integration	The use of sensory input, including vestibular and proprioceptive stimulation to prompt an adaptive response in order to enhance the organisation of neurological processes involved with motor planning and motor learning[4]	Organising sensory input, postural security, body awareness, tactile discrimination, calming sensory input	Group sessions are started and ended with organising and calming sensory input to assist with arousal regulation in preparation for learning, focus and emotional regulation.
Task-Specific Training	The repetitive practice of a meaningful motor skill-based activity that is specific to an intended outcome[5]	Motor planning, pencil grip, pencil control, scissors skills, ball skills, listening skills, focus, task completion	Functional play, sport related and fine motor pre-writing skills activities are used to promote school-readiness tasks. Tasks also require focus, planning and a level of independent working to complete tasks

[1] Smits-Engelsman et al., 2018
[2] Smits-Engelsman et al., 2018
[3] Vaivre-Douret, 2014
[4] Lane et al., 2019
[5] Van Cappellen-van Maldegem et al., 2018

Role Players

The scoping review indicated the most frequently used role-players as facilitators of an intervention to be occupational therapists and physiotherapists. Fewer studies also included teachers and kinesiologists as facilitators or co-facilitators (Van der Walt et al., 2020a). The Delphi study participants, who considered facilitators for the intervention against the unique socio-economic background and limited resource availability in the West Coast region (van der Walt et al., in preparation) recommended that therapists (occupational therapists, physiotherapists or kinderkineticists) take an organising, advisory and supportive role to the intervention, while the screening and intervention will be facilitated by a grade R teacher or PE teacher. In this way, a task-shifting approach is adopted, like the provision of care in rural communities for people living with HIV/AIDS (Dawad & Jobson, 2011; World Health Organization, 2008). An added role named by the Delphi study, was that of assistant to the facilitator, which was recommended to be a teaching assistant (Van der Walt et al., in preparation). The allocation of an assistant will, however, be dependent on the staff-structure of individual schools. While it is ideal to have both a facilitator and assistant in an intervention group, poor-resourced schools may not allow for two members of staff to be involved in a small-group intervention. In fact, it is recommended that the screening process and programme is co-facilitated by the advising-therapist as part of training reinforcement, for at least the first two sessions where it is implemented for the first time.

In the current health and education systems of South Africa, kinderkineticists are not yet part of the therapy teams, which suggest that the advisory role for the intervention in local schools would most likely be played by an occupational therapist or physiotherapist. The advisor's role will be to provide training with regards to the screening and intervention process. They will further assist with the interpretation of the screening results and planning of the sessions prior to the intervention and will be available for advice and guidance throughout. The advising therapist will also be available for follow-up and recommendations following the outcomes evaluation. In this way, some of the role of therapists can be transferred to the teaching team (Ward et al., 2017).

Service Delivery Model and Structure

Delphi participants agreed on a school-based programme, starting in the first term of the school year (Van der Walt et al., in preparation). It is proposed that the programme is incorporated in the allocated two-hour time frame per week for PE as required in Curriculum

Assessment Policy Statement (CAPS) document (Department of Basic Education, 2011a). CAPS is an educational policy document which gives guidance to teachers on what to teach and how to assess (South African Government, 2021). PE forms part of the Life Skills curriculum in government schools in South Africa. This will allow for two sessions per week as part of a weekly routine: one gross motor activity session and one fine motor skills session. The CAPS document further provides guidance to teachers on general activities targeting locomotor, perceptual-motor, balance, rhythm, coordination, laterality and spatial orientation (Department of Basic Education, 2011a). The programme will incorporate these areas of focus and could replace at least part of the regular given PE time for children with motor impairment.

Hopscotch is a 12-week programme, illustrated in Figure 5.1. Week 1 includes training of teachers to facilitate the intervention, and planning of screening procedures. In Week 2, the whole grade R class is screened, to identify children with motor skill impairment who will be included. Week 3 provides time for the advising-therapist and teacher-facilitator to interpret assessment results, and plan the programme delivery. It is proposed that group intervention sessions are run over eight weeks (Van der Walt et al., in preparation), from Week 4 to 11. Each session will last 45 minutes and will take place in a small-group format of maximum eight children per group (Smits-Engelsman et al., 2018). These sessions are facilitated by a teacher. In Week 12, the progress made by the children is measured by repeating the DCDQ-2.

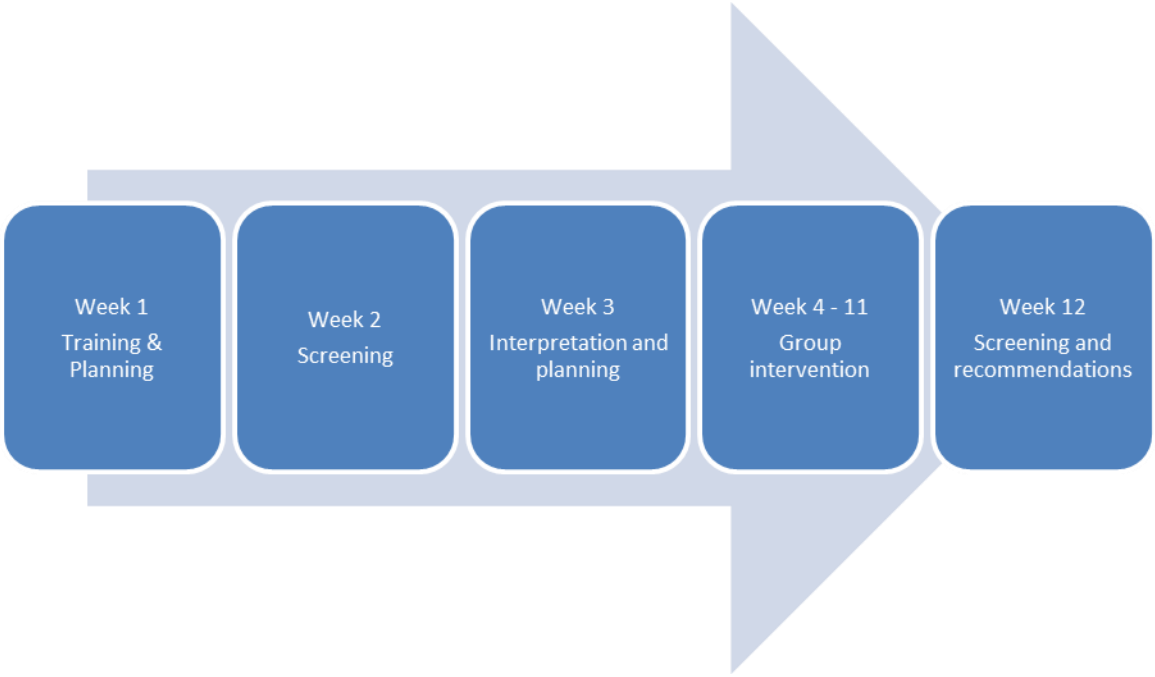

Figure 5.2: Time frame of motor skill intervention

Week 1: Training and Planning

Sufficient collaboration between all role players in community, health and education sectors is crucial to ensure the effectiveness and sustainability of the intervention (Camden et al., 2015; Missiuna, Pollock, Levac et al., 2012; Ratzon et al., 2009b). In line with Missiuna, Pollock, Levac et al.'s (2012) study to develop an occupational therapy school-based service delivery model, our intervention aims to empower teachers to identify and manage children with motor skill impairment. This process of task-shifting is dependent on existing local supported systems, e.g., health and education (Dorsey et al., 2019) as well as the local community. By involving the community, knowledge and understanding of motor skill impairment, and a general awareness of these children's frustrations and challenges are created, which may lead to early identification, management and improved school readiness (Missiuna, Pollock, Levac et al., 2012). Community involvement could include attending general information sessions about the project, funding or construction of playground equipment, and collecting or donating equipment needed for the intervention activities. These aspects need to be considered and started at least three months prior to the onset of the 12-week intervention period.

Delphi study participants suggested a training manual as part of the intervention guidance to teacher-facilitators (van der Walt et al., in preparation). To assist with thorough training and

support (Ward et al., 2017), the manual will include an overview of signs and functional implications of motor skill impairment, step-by-step guidance on using and scoring the screening tool, and a detailed outlay of the activity programme including the aims, equipment needed and activity instructions for each session. The programme will be supplemented with diagrams and pictures for clarity.

The first week of the programme will be used for teacher-therapist collaboration, planning and training. The training sessions will include all topics addressed in the training manual as well as practical demonstrations and an opportunity to practice screening and activities.

Teacher-facilitators will be guided to follow a child-centred approach (de Gangi et al., 1993) as recommended by Delphi study participants. The following was agreed on as the main principles of a child-centred approach for this programme: the activities should be presented through means of enabling rather than teaching; there should be clear boundaries and rules and children will be encouraged to formulate their own functional aim/aims which they wish to achieve. A child's own functional aim may, for example, be to be able to climb onto the jungle gym independently or cut on a line around a shape. Furthermore, the activities used should be guided by the participating children's (children between the ages of 5 and 7) interest and there should be opportunity for choice within activities (de Gangi et al., 1993; Lahav et al., 2008).

Week 2 and 3: Screening and Interpretation

The second week of the intervention identifies the children who experience motor skill impairment, and their specific challenges. Delphi study participants recommended that a screening tool is used, with guidance from a therapist. For the first implementation of an intervention programme, the advising-therapist will attend at least part of the screening process. Teacher-facilitators will also receive clear instruction when to refer for furthermore in-depth assessment by a therapist (van der Walt et al., in preparation).

The requirements for our screening tool were that it should be validated for use for children aged five to seven years old, in the school environment by teachers-facilitators. It should be time and cost effective with the main purpose of initial identification of potential motor impairment (Asunta et al., 2019). Delphi participants recommended several tools, including the DCDQ-2 (DCDQ, 2016), Movement Assessment Battery for Children checklist (MABC) (Henderson et al., 2007), the Clinical Observation of Gross Motor Skills (Jordaan, 2017), the

short form of the Bruininks Oseretsky Test of Motor Proficiency (Jírovec et al., 2019), Australian Kid sense (Kid Sense, 2020) and informal developmental questionnaires developed by individual therapists.

The DCDQ-2 was the only screening tool which adhered to all requirements. It is a standardised web-based free screening tool, which was designed for use by parents, but can be used by parents and teachers together (DCDQ, 2016). The questionnaire takes 10–15 minutes to complete, but it is expected that it may take slightly longer for teachers who do not know the child well, as motor skill aspects need to be observed through activity participation first. It consists of 15 items, grouped together in the three areas of control during movement, fine motor and handwriting, and general coordination. The total score is interpreted as falling into a range of 15–46, indicating motor skill impairment or a possible diagnosis of DCD or into the range of 47–75, indicating probable sufficient motor skills. Following De Milander et al.'s (2019) findings that the Canadian version of the DCDQ-2 together with the MABC-2 parent questionnaire were not reliable indicators of motor skill impairment among South African children, further cross-cultural testing and validation need to be done. The planned exploratory trial provides opportunity for further reliability testing of the DCDQ-2 in a local low socio-economic setting alongside a performance test, e.g., the MABC-2 as part of the assessment tools.

During the initial training sessions, the screening tool will be explained, demonstrated and practiced. The advising-therapist will be available for initial screening procedures until the teacher-facilitator is confident to independently administrate the screening. Interpretation of the screening results will be done through discussion between the advising-therapist and teacher-facilitator in the third week.

Week 4 to 11: Using Therapeutic Activities to Address Motor Skill Impairment

In line with the activity-based body-function oriented approach, this intervention programme focuses on functional play activities to improve the fundamental areas of gross and fine motor skills and develop competence in functional daily activities and school readiness (Smits-Engelsman et al., 2018). The intervention aims to address the underlying components of gross and fine motor skills (body-functions) through functional activities to improve the execution of a task. SI (Ayres & Marr, 2007; Lane et al., 2019) and PMT (Sugden & Dunford, 2007) underpin the treatment of deficits in components of motor skills.

Sensory Integration refers to the processing of vestibular, proprioceptive and sensory tactile information, which affects ocular control, postural skills, bilateral integration, praxis, and sensory modulation (Lane et al., 2019). Sensory modulation refers to the level of alertness or activity levels that occur through the neurological process of organising inhibitory and excitatory sensory stimulation. Difficulty in the modulation of sensory input may lead to sensory over-responsivity, sensory under-responsivity, and sensory seeking/craving behaviour (Cohn et al., 2000). Carefully selected activities may provide organising and calming proprioceptive and vestibular sensory input to regulate the children's levels of alertness (arousal levels) (Lane et al., 2019). A child who is overresponsive to sensory stimulation may need organising, calming input to prevent sensory overload and create a "just right" level of alertness to be able to focus and participate. On the other hand, a child who is under-responsive may need the input to stimulate sensory awareness and once again create a readiness to focus and participate (Cohn et al., 2000).

Visual-Perceptual Motor theory reasons that the treatment of body function and visual perceptual components underlying motor skill difficulty will subsequently transfer to functional areas of concern (Sugden and Dunford, 2007). Components of gross motor skills associated with body-function include postural skills (strength and agility); balance (static and dynamic balance) and coordination, while fine motor skill components refer to hand skills (hand strength, fine motor grasps, finger isolation and tactile discrimination) (Wang, 2004). Activities chosen for the Hopscotch programme also provide opportunity for task-specific training of age-appropriate functional skills such as ball skills, agility on the jungle gym and pencil skill tasks (van Cappellen-van Maldegem et al., 2018).

The Hopscotch programme uses active gross motor and fine motor play, and arts and crafts as functional activities in the intervention to address motor skill impairment. As suggested in a proposed study focussing on play and leisure for children with motor impairments (Kolehmainen et al., 2011), the Hopscotch programme aims to improve motor performance, which will in turn increase these children's participation in play. The lists of prescribed equipment and materials in the national curriculum statement for foundation phase Life Skills (Department of Basic Education, 2011a) were considered when developing the activities in the programme. Unfortunately, as identified during the prevalence study, playground equipment is not always available as prescribed (van der Walt et al., 2020b). The same study also showed that there is a link between a lack of playground equipment and the attainment of

age-related fine motor skills. It is therefore proposed that parent and community involvement is sought to ensure basic outdoor playground equipment as well as materials required for the fine motor skill activities for grade R children.

A building plan and directions for the basic requirements of a jungle gym will be included in the training manual as a pre-requisite for the intervention. The researcher believes that the playground will benefit all grade R children through active play and the facilitated sessions will assist those with motor skill challenges with confidence building to allow ongoing free play and practice on the outdoor playground.

Delphi participants recommended that the programme should be affordable and accessible to all, while not requiring specialised therapy equipment. Where possible, advice will be given for cost-effective ways to obtain or make equipment and materials as needed (e.g., playdough recipe or soap bubble solution instructions). Figure 5.3 lists the equipment and materials that will be needed for the programme.

Equipment and materials – minimum requirements

(DIY instructions in manual)

1. Jungle gym including at least a ladder, ramp with rope, platform and slide
2. Balance beam
3. Five tyres
4. Ten large hoops
5. Ten small hoops
6. Two large boxes/crates/buckets
7. Two large blankets/towels
8. Five large cardboard boxes
9. Tug-of-war rope
10. Five medium size balls (must be able to bounce)
11. Five tennis balls/other small balls
12. Five containers with soap bubbles and wands
13. Ten beanbags
14. Music
15. Arrows
16. Footprints
17. 10 Balloons
18. Ten markers/cones
19. Playdough
20. Plenty of scrap paper/newspaper
21. Plain paper A4 size
22. Wax crayons /pastels
23. Paint
24. Paintbrushes
25. Cardboard rollers (toilet roll/ kitchen roll)
26. Scissors
27. Glue
28. 20 Marbles
29. 5 x flat boxes or containers

Figure 5.3: Minimal requirements for equipment and materials for the Hopscotch programme

The activities aim to be age-appropriate and playful but are also task-specific to address school readiness skills directly and indirectly (e.g., pencil skills and scissors skills). The activities are graded and become more challenging as the programme continues through the weeks. Although this programme focuses on motor skills, additional benefits include opportunities for social skill development, following visual and auditory instructions, visual and auditory focus and attention and general self-confidence development. These are all areas that can be affected by motor skill impairment (Chung, 2018). Table 5.3 Hopscotch summarises the proposed programme according to session detail, components of motor skills addressed in each session and equipment needed.

As an example, week four of the programme will now be analysed in detail to explain the underlying theory and application of described approaches and processes: The first session of week four focuses on gross motor skills. A 10-minute warm-up activity of animal walks provides proprioceptive, vestibular and tactile input, facilitating postural tone, stability and an organised level of alertness. The activity further encourages bilateral integration and motor planning. For this activity, an animal-walk guide with visual diagrams and descriptions will be available in the facilitators' manual. For the next activity (20 minutes) the manual will provide a diagram of an obstacle course with a list of equipment needed. The obstacle course provides opportunity to improve postural stability, body awareness, dynamic balance, motor planning, bilateral integration and midline crossing and spatial awareness. Ball skills are addressed in the next 10 minutes through a balloon game which promotes eye-hand coordination, midline crossing and bilateral integration. A five-minute cool down activity applies sensory integration principles through a stretching activity (proprioceptive and vestibular processing) as a calming and organising strategy. A stretch guide with visual diagrams will be available in the manual. The activities provide practice opportunity (task-specific training principles) for jungle gym agility,

The second session of week four is a fine motor session, which similarly follows a 10-minute warm-up of hiding and finding a small toy in a ball of playdough. The resistance of the playdough provides proprioceptive and sensory-tactile input to improve awareness of the hands prior to a fine motor task. The 30-minute fine motor task activity promotes eye-hand coordination, midline-crossing and functional finger grasps as children thread pasta-tubes onto straws positioned vertically in balls of playdough. Finally, the five-minute cool-down activity again uses sensory integration principles by ending the session off with stretches

from the stretch guide in the manual to provide calming, organising input. All activities are described in the manual, while required equipment and materials are listed and supported with visual guidance where appropriate. In these sessions, motor skill components (e.g., balance and hand strength) as body functions are addressed through participation in the functional tasks of play and threading, which further aim to improve, through practice, confidence in the playground, ball skills and a functional pencil grip. A body-function oriented approach is thus applied, using sensory integration, visual-perceptual motor and task-specific training principles.

Week 12: Evaluation

In week 12 teacher facilitators will re-evaluate the children using the DCDQ-2. According to the DCDQ-2 guidelines, the test can be re-administrated within a three-to-six-month period as a reliable pre-post intervention tool (DCDQ, 2016; Maharaj & Lallie, 2016). The children's progress towards their individual chosen aim/s will also be revisited. Successful intervention is indicated by an improvement in the DCDQ-2 scores and the child's perception of his aims reached. Further concerns and recommendations will be discussed by the teacher and supportive therapist. Where possible, parent involvement will be sought. Children who do not show progress or raise continued concern will be referred for more formal assessment and intervention.

Table 5.3: The Hopscotch Programme

Week	Time length	Section	Motor skill components addressed	Activity	Equipment/aids
1	2 days	Screening and programme		Training	Training manual
2	1 week	Screening		Complete screening questionnaires	DCDQ questionnaire
3	2 days	Interpretation and planning		Consultation	Training manual
4GM	10 min	Gross motor warm-up	BI /MP /OSI PS / PT	Animal walks	Animal walk guide
	20 min	Obstacle course	BA / BI / DB / MC / MP / PS / SA	Obstacle course 1	Obstacle course diagram 1: 8 hula-hoops; jungle gym
	10 min	Ball skills	BI / EHC / MC	Balloon game	1 x balloon for each child
	5 min	Cool down	CSI	Stretches	Stretch guide
4FM	10 min	Fine motor warm up	HS / OI / TD	Hidden object in clay/playdough	Playdough*' small toy/marble to hide
	30 min	Activity	EHC / FMG / MC	Threading with straw, pasta and playdough	Playdough, 2 x straws per child, 10 pasta tubes per child
	5 min	Cool down	CSI	Stretches	Stretch guide
5Gm	10 min	Gross motor warm-up	BI / MC / MP / OSI	Tyre role relay	2 - 5 tyres
	20 min	Obstacle course	BI / DB / MC / MP / PS / PT	Obstacle course 2	Obstacle course diagram 2: 2 buckets/boxes; 2 hula-hoops, jungle gym
	10 min	Ball skills	BI / EHC / MC / SA / SB	Ball play	1 x medium size bouncable ball per child
	5 min	Cool down	CSI	Stretches	Stretch guide
5FM	10 min	Fine motor warm up	EYC / HS / OSI	Scrunch ball	5 x pieces of scrap paper per child, 1 bucket
	30 min	Activity	BI / EHC / FMG / HS / MC / TD	Newspaper teared paper collage	Scrap paper for tearing (coloured or newspaper), collage templates
	5 min	Cool down	CSI	Stretches	Stretch guide
6GM	10 min	Gross motor warm-up	BA / MP / OSI / PS / PT / SA	Cardboard box pull, push and slide	1 x large cardboard box between 2 children

Week	Time length	Section	Motor skill components addressed	Activity	Equipment/aids
	20 min	Obstacle course	BA / BI / DB / MP / PS / PT / SA	Obstacle course 3	Obstacle course diagram 3: 10 x small hoops, 2 large hoop, 10 beanbags*
	10 min	Ball skills	BI / EYH / MP / SA	Blanket catch	1 x blanket/towel between 2 children, 1 x between 2 children
	5 min	Cool down	CSI	Stretches	Stretch guide
6FM	10 min	Fine motor warm up	FI / FMF / HS / PS / TD	Spider ball	1 x small ball for each child
	30 min	Activity	BI / EHC / FI / FMG / HS / MC / TD	Scrunched paper hedgehog	1 x piece of scrap paper for each child, 10 x washing pegs for each child
	5 min	Cool down	CSI	Stretches	Stretch guide
7GM	10 min	Gross motor warm-up	DB / OSI / PS / PT / SB	Tug-of-war	Tug-of-war rope
	20 min	Obstacle course	BA / BI / DB / MC / MP / SA	Obstacle course 4	Obstacle course diagram 4: tug-of-war rope, 10 x small hoops, 2 large hoops, 5 x tyres
	10 min	Ball skills	DB / EFC / SA / SB	Kick ball towards a target	1 x ball per child, 1 x tyre per child
	5 min	Cool down	CSI	Stretches	Stretch guide
7 FM	10 min	Fine motor warm up	BA / BI / OSI / SI	Simon says	Simon-says guide
	30 min	Activity	BI / EHC / MC / TD	Marble paint	3 x marbles per child, 1 x paper per child, different colours watery paint, 1 x small cardboard box/container per child
	5 min	Cool down	CSI	Stretches	Stretch guide
8 GM	10 min	Gross motor warm-up	BA / BI / MP / OSI / SA	Ball relay over and under	1 x medium size ball
	20 min	Obstacle course	BI / DB / MP / SA	Obstacle course 5	Obstacle course diagram 5: Arrows*, 10 x small hoops, rope, sack for sack jumping
	10 min	Ball skills	BI / EYC / MC / SA	Beanbag juggle	2 x beanbags per child
	5 min	Cool down	CSI	Stretches	Stretch guide
8FM	10 min	Fine motor warm up	EYC / FI / OSI	Finger soccer	2 x marbles per child

Week	Time length	Section	Motor skill components addressed	Activity	Equipment/aids
	30 min	Activity	BI / EHC / HS / MP / MP / SA / TD	What is hiding in the grass?	1 x Hide and seek worksheet per child, 1 x green paper* per child, glue, scissors
	5 min	Cool down	CSI	Stretches	Stretch guide
9GM	10 min	Gross motor warm-up	BI / EHC / MP / OSI	Bubbles: blow, catch and stomp	1 x bubble solution and wand between 2 children*
	20 min	Obstacle course	BA / BI / DB / MC / MP / SA	Obstacle course 6	Obstacle course diagram 6: Rope, footprints*, markers*
	10 min	Ball skills	BA / EHC / MC / SA	Target throw	1 x beanbag and tyre per child
	5 min	Cool down	CSI	Stretches	Stretch guide
9FM	10 min	Fine motor warm up	BI / MC / MP / OSI / TD	Clapping game	Clapping game guide
	30 min	Activity	BI / EHC / HS / MC / TD	Cardboard roll printing	1 x cardboard roller per child, 4 x paper per child, paint (various colours), paint brushes
	5 min	Cool down	CSI	Stretches	Stretch guide
10 GM	10 min	Gross motor warm-up	BA / BI / MC / MP / OSI / SB	Musical statues	Music (singing/instrument/recording)
	20 min	Obstacle course	BI / DB / MC / MP	Obstacle course 7	Obstacle course diagram 7: 10 small hoops, rope, balance beam *
	10 min	Ball skills	BA / BI / DB / EHC / MC / MP / SA	Bouncy ball around markers	1 x medium size bouncable ball per child, 5 markers
	5 min	Cool down	CSI	Stretches	Stretch guide
10 FM	10 min	Fine motor warm up	OSI / TD	Feely game	Selection of small objects (feely guide), feely sack/bag 1 x per child
	30 min	Activity	EHC / FI / MC / MP / TD /	Giraffe finger print picture	Giraffe template; colouring in wax crayons or pastels, yellow/brown finger paint
	5 min	Cool down	CSI	Stretches	Stretch guide
11 GM	10 min	Gross motor warm-up	BA / BI / MC / MP / PS / PT / SA	Planning of own obstacle course	Tyres, small hoops, large hoops, balance beam, buckets, balls, rope, beanbags, arrows, footprints
	20 min	Obstacle course	BA / BI / MC / MP / PS / PT / SA	Obstacle course 8	Obstacle course children's own design

Week	Time length	Section	Motor skill components addressed	Activity	Equipment/aids
	10 min	Ball skills	BA / BI / EFC / MC / MP / SA	Mini soccer	Goal posts, medium size kickable ball
	5 min	Cool down	CSI	Stretches	Stretch guide
11FM	10 min	Fine motor warm up	EHC / FI / MP / OSI	Hand shadows	Hand shadow guide
	30 min	Activity	BI / EHC / FI / FMG / HS / MC / MP	Paper plane folding	2 x scrap paper per child (A 4 size), instruction sheets, crayons
	5 min	Cool down	CSI	Stretches	Stretch guide
12	1 week	Screening and recommendations		Complete screening questionnaire/consultation	DCDQ questionnaire

Key

BA: Body Awareness; BI: Bilateral Integration; CSI: Calming Sensory Input; DB: Dynamic Balance; EFC: Eye Foot Coordination; EHC: Eye Hand Coordination; FI: Finger Isolation; FMG: Fine Motor Grasps; HS: Hand Strength; MC: Midline Crossing; MP: Motor Planning; OSI: Organising Sensory Input; PS: Postural Security; PT: Postural Tone; SA: Spatial Awareness; SB: Static Balance; TD: Tactile Discrimination

Summary and Recommendations

This proposed motor skill programme was purposefully developed for grade R children in a rural, low socio-economic area of South Africa. It is a cost-effective programme that could be implemented in the existing curriculum of life skills and PE. The programme requires oversight by a rehabilitation health professional but can be executed/facilitated by current school staff. Although it is aimed at identifying and treating children with motor skill challenges, all grade R children could benefit from the programme (Ferguson et al., 2015). Teachers will be empowered to better understand motor learning and learn how to identify children that struggle to attain certain motor skills which may impact their readiness for formal education. The implementation of the programme is dependent on collaboration between health and education systems and requires multidisciplinary and community involvement.

There are also possible barriers that need to be recognised such as the willingness of teachers to participate and time constraints, especially with initial implementation (Dambisya & Matinhune, 2012). The researcher believes that the thorough consideration of the national and regional educational structure and curriculum assists in minimising the effect on the workload of the facilitators as it is proposed that the Hopscotch programme is integrated in the existing curriculum (Iwelunmor et al., 2017). On implementation level, it will be important to consider the individual school structures and programmes as well as the local stakeholders to promote ownership and motivation to participate (Dorsey et al., 2019).

Chapter 6

The Hopscotch motor skill intervention for Grade R children in a rural low resourced area: Exploratory stepped-wedge cluster Randomised Controlled Trial protocol

Introduction

The protocol manuscript describes the design of a stepped-wedge cluster randomised controlled trial. It can be seen as the initiation of the feasibility/piloting phase of complex intervention development, which follows on from the developmental phase.

An added secondary objective of the study is to determine the concurrent and discriminant validity of the DCDQ (second edition), alongside the MABC-2. The importance of a reliable, yet cost effective and easy-manageable screening tool is evident throughout the development of the programme and the exploratory RCT provides an opportunity to determine whether the DCDQ is an appropriate screening tool for the Hopscotch programme.

The protocol for the exploratory RCT is ready to be submitted for publication to the *British Journal of Occupational Therapy* (SAGE publishing, 2021). The journal accepts protocols for RCTs and this RCT meets the scope of the journal, i.e., it is of international interest and will advance knowledge with regards to policy and practice.

Paper 4: The Hopscotch motor skill intervention for Grade R children in a rural low resourced area: Exploratory stepped-wedge cluster Randomised Controlled Trial protocol

Article Cover Page

The following article was written in preparation for submission to the *British Journal of Occupational Therapy*.

The researcher followed all requirements as prescribed by the *British Journal of Occupational Therapy*. These instructions prescribe, for example, the length of the abstract and the total manuscript as well as the referencing style to be used. Journal requirements can be viewed at https://uk.sagepub.com/en-gb/eur/journal/british-journal-occupational-therapy#submission-guidelines

However, in order to provide a better insight into the data and improve readability of the dissertation, the following adaptations to the *British Journal of Occupational Therapy* author guidelines were accepted in the article manuscript:

- Details of authors and ethics committee are not blinded in the manuscript
- The figure is inserted in the manuscript for readability purposes

Paper 4: The Hopscotch motor skill intervention for Grade R children in a rural low resourced area: Exploratory stepped-wedge cluster Randomised Controlled Trial protocol

Short tile: Exploratory RCT protocol: Hopscotch programme

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Research ethics

Ethical approval was obtained from the Health Research Ethics Committee of Stellenbosch University

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Declaration of conflicting interests

The authors confirm that there is no conflict of interest.

Statement of contributorship

JW obtained ethical approval as part of a larger PhD study. JW, NP and MU conducted research leading up to the protocol manuscript. JW planned the protocol and wrote the first draft of the

manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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The Hopscotch motor skill intervention for Grade R children in a rural low resourced area: Exploratory stepped-wedge cluster Randomised Controlled Trial protocol

Abstract

Introduction: The Hopscotch motor skill intervention programme targets motor skill impairment among pre-school children in rural low socio-economic areas. The programme aims to deliver high quality yet affordable and sustainable intervention to children in low-resourced areas. This protocol describes an exploratory RCT to determine the preliminary effect of the programme on the motor and early academic skills of Grade R children on the West Coast of South Africa.

Method: The study follows a stepped wedge cluster randomised trial design. Children identified with significant motor skill impairment or fine motor skill impairment (scores <15th% on the Movement Assessment Battery for Children 2) will receive the 8-week Hopscotch motor skill intervention from an occupational therapist in two randomised groups. The MABC-2 and Kaufman Test of Educational Achievement will be administrated to measure progress quantitatively, while qualitative data will be gathered from the programme facilitator through an electronic diary. A linear mixed model is proposed for the primary analyses of data.

Conclusion: We envisage that the results of the exploratory RCT could lead the way for further evaluation and adaptation of the Hopscotch programme using a task-shifting approach, in preparation for regional or national implementation.

Trial Registration**:** For registration with the South African National Clinical Trials Register (SANCTR).

Keywords: Motor skill impairment, intervention, rural, low resourced, protocol, RCT

Introduction

Children living in low socio-economic rural areas seem to be doubly disadvantaged. While they are at a higher risk of developing motor skill difficulties, the therapy resources they need are limited. This is the case in the rural West Coast area of South Africa where 14.5% of grade R children were found to experience significant motor skill impairment (van der Walt et al., 2020b). The prevalence of fine motor skill difficulties was even higher at 24.6%. The results correlated with similar studies, for example, a Brazilian study where 33% of children in a disadvantaged setting were thought to have motor skill difficulties associated with Developmental Coordination Disorder (DCD) (Valentini et al., 2015), and a study in the United Kingdom that showed that low SES significantly influences motor skill development ($p<0.001$) (Morley et al., 2015). These figures are high when compared to general prevalence figures of DCD among school-aged children at 7% (Caçola and Lage, 2019).

Children with motor skill impairment need therapeutic input to make progress and to avoid regression (Hillier, 2007). Social development, independence skills and academic achievement and progress may also be affected (Blank et al., 2019). Fine motor and gross motor skill proficiency have in fact been identified as indicators of academic ability and progress (Botha and Africa, 2020; Kim et al., 2020). However, therapy resources in rural and low socio-economic areas are often limited. In South Africa, occupational therapy and physiotherapy services are often difficult to access in poorer communities (Narain and Mathye, 2019; Ned et al., 2020). A qualitative study by Sonday et al. (2012) further identified a lack of resources among therapists working in schools. Difficulties associated with physical geography, therapy staff shortages and limited referral options are challenges therapists who work in rural areas can relate to (Roots et al., 2014).

Although motor skill impairment can be linked to various conditions, including Foetal Alcohol syndrome (FAS) (Kalberg et al., 2006), Human Immunodeficiency Virus (HIV)/acquired immunodeficiency syndrome (AIDS) (Ferguson and Jelsma, 2009) and developmental conditions such as Attention Deficit and Hyperactivity Disorder (ADHD) (Tseng et al., 2004) and specific learning difficulties such as dyslexia (Viholainen et al., 2006), research about motor skill interventions mostly focuses on Developmental Coordination Disorder (DCD). DCD is a neurodevelopmental disorder, where the acquisition and execution of coordinated motor skills are below the expected age norm and not in line with the opportunity levels a child had to acquire age-appropriate skills (Blank et al., 2019). Researchers seem to agree that most intervention methods and approaches have positive effects, and that any intervention is better than no intervention (Colombo-Dougovito and Block, 2019). A few studies have highlighted some interventions as more positive – a systematic review of high quality randomised control trials concluded that neuromotor task training, task-oriented motor training and motor imagery, together with task practice training, were the most effective reported interventions to improve motor skills in children with DCD (Preston et al., 2017). Another systematic review and meta-analysis found positive evidence for the use of activity-oriented and body-function oriented interventions for children with DCD (Smits-Engelsman et al., 2018). A systematic review looking at school-based motor skill interventions concluded that schools are effective settings for motor skill intervention. However, the extent of the progress depended on the type of intervention (Eddy et al., 2019).

Almost all of the evidence for the effectiveness of motor skills interventions for pre-school children with DCD comes from high-income countries. Across the three recent systematic reviews, only six

studies including pre-school children (<6 years) were conducted in low- and middle-income countries (LMIC). In addition, these trials do not include motor skill impairment as a hidden disability in conditions such as HIV and FAS. We conducted a scoping review as a first step to make these research advances available to children living in low socio-economic areas, such as the rural West Coast of South Africa. This scoping review identified key features of interventions that aim to improve motor proficiency in pre-school children (Van der Walt et al., 2020a). A follow-up Delphi study, through expert participation, produced guidelines for a motor skill programme developed for grade R children in government schools in a specific rural low socio-economic area (Van der Walt et al., in preparation). This led to the development of the Hopscotch motor skill intervention programme.

An important feature of the Hopscotch programme is the use of task-shifting within an educational model. Task-shifting refers to non-specialists providing treatment under supervision (World Health Organization, 2017). While motor skill intervention remains a specialised therapy area within occupational therapy, physiotherapy and kinesiology (Van der Walt et al., 2020a), it is suggested that teachers and teaching assistants take on the role of programme facilitators. This can only occur with thorough training and support from therapists (Ward et al., 2017). The process of task-shifting is well-known in Africa as an alternative approach to provide health and community care to children in rural areas (Dorsey et al., 2019; Marotta et al., 2018). This exploratory study aims to assess the preliminary outcomes of the Hopscotch motor skill intervention, designed for pre-school children in rural, low socio-economic areas. Results will direct future feasibility studies, trials and research to apply a task-shifting approach (In, 2017).

Aims and Objectives

The aim of the study is to determine the preliminary effect of the Hopscotch programme on the motor skills and academic skills of grade R pupils. The primary objectives of the study are:

- to determine the change in motor skills and academic ability over the intervention period;
- to compare the change in motor skills and academic skills between the intervention and control group;
- to determine the sustainability of change for the intervention group;
- to determine the feasibility of the study for wider evaluation.

A secondary objective of the study is to determine the concurrent and discriminant validity of the Movement Assessment Battery for children (second edition) and the Developmental Coordination Disorder Questionnaire (second edition)

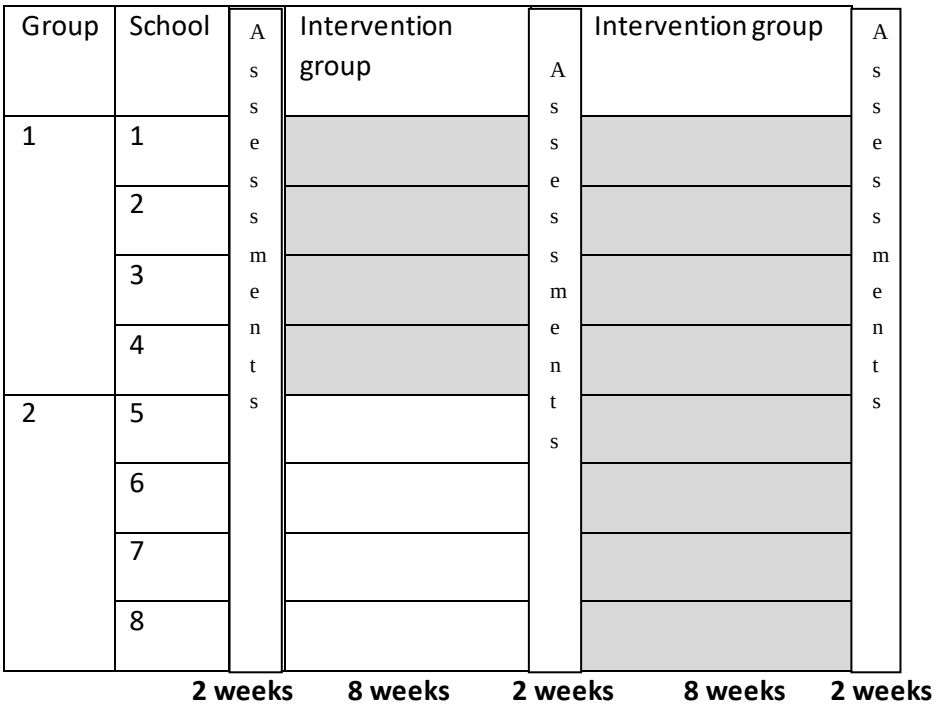
Method

We followed guidelines for the reporting of pilot and feasibility trials (Thabane and Lancaster, 2019), based on the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) checklist to described the methodology and design of the study (SPIRIT, 2013) and the Consolidation Standard of Reporting Trials (CONSORT) extension to pilot trials (CONSORT, 2010).

Design

A stepped wedge cluster randomised trial design will be used for this study. This design allows for testing to occur over a period of time, with staged exposure of the intervention to clusters (Copas et al., 2015; Ni Mhurchu et al., 2010). For this study, testing will take place at baseline (M1), post-intervention (M2) – within two weeks after the end of intervention – and post-intervention (M3) at the end of the school year. An experimental and control group will be assigned with equal allocation ratio. The experimental group (Group 1) will participate in the intervention first. Hopscotch is an eight week programme designed by the researchers during the development phase of this complex intervention (Skivington et al., 2018). Two sessions of 45 minutes will take place weekly, one for gross motor and one for fine motor skill development. The intervention will be delivered in schools within the West Coast of South Africa. A list of study sites is available from the corresponding author. The intervention sessions will be facilitated by an experienced occupational therapist for the exploratory trial. However, future feasibility studies are planned and it is envisaged that the programme will be facilitated by teachers in the future. After the intervention, the control group (Group 2), will participate in the same programme, so providing an equal opportunity. Group 2 will also be re-tested at the end of the programme to assess progress, while re-assessment of Group 1 will provide information about their long-term progress. The stepped wedge cluster randomised trial design can be viewed in Figure 1.

Figure 1: Diagram to illustrate the stepped-wedge design process



Sample

Sample size is calculated as recommended to prevent type II errors trials (Cocks and Torgerson, 2012; Viechtbauer et al.). A sample size of at least 50 children would be required for a confidence level of 90% and a probability level of 5%. This sample size correlates with the sample size (57 children) in four schools of a pilot clustered randomized trial, where a gross motor skill programme for toddlers was piloted (Veldman et al., 2015). For our study, eight government primary schools in a specific municipal area, with grade R classes of between 30 and 40 children in the class, will be invited to participate in the study (N = 256). We can estimate that 24.6% of children are likely to experience motor skill impairment (van der Walt et al., 2020b), predicting a sample size of 63 children.

Participants

All grade R children (age 5 – 7) from the eight schools will be invited to participate in the study. All children whose parents have consented with scores below the 15th percentile, and whose difficulties are not attributed to neurological or muscular conditions, will be included in the Hopscotch intervention programme. Teachers will complete the DCDQ-2 questionnaire (DCDQ, 2016) at the same time as supportive data. The concurrent and discriminant validity of the assessments will be analysed for future programme evaluation and development.

Consent process

Permission will be obtained from the relevant education department, chosen schools as well as the Minister of Health.

Written informed consent will be obtained from the parents for their children to participate in the study by a research assistant. As children are below seven years of age, assent will not be taken. However, the willingness to participate in the intervention sessions will be taken into consideration by the occupational therapist that facilitates the programme.

Randomisation and blinding

The participating schools will randomly be allocated to Group 1 or 2 by simple randomisation in MS Excel (Kim and Shin, 2014). Randomisation will take place two weeks prior to the assessments and will be administrated by the research assistant. The independent researcher who will administrate the assessments will be blinded to the allocation of schools to Group 1 or 2. While all grade R learners whose parents consented will be included in the assessment process, children identified with motor skill impairment in schools allocated to Group 1 will receive the intervention first.

Procedure

A research team will be appointed to the project as follow – the principal investigator is an occupational therapist who will oversee the project and implement the Hopscotch programme at the schools. A research assistant who is a registered health professional will complete the randomisation, maintain the databases, monitor confidentiality and blinding procedures, and will be responsible for administration tasks. Two independent occupational therapists will be appointed to conduct the standardised assessments, while grade R teachers at the schools will complete the DCDQ-2 screening questionnaires. An external therapist will be asked to assist with quality control through site visits.

Data collection

The following aspects will be assessed at M1, M2 and M3 in the school environment:

Primary outcome measure

The level of motor proficiency is the primary outcome measure and will be measured using the MABC-2. This standardised test will be conducted by two occupational therapists as independent researchers, blinded to the hypothesis to prevent bias. The MABC-2 is a performance test that provides objective quantitative data on motor skills performance (Henderson et al., 2007). The test provides clear criteria to indicate significant motor skill difficulties. It has not yet been validated for the South African population, to our knowledge, but has been researched and used as a reliable tool worldwide (Blank et al., 2019; Maharaj, 2016; Valentini et al., 2015). In addition, it was used for an initial prevalence study conducted by the authors with this population (van der Walt et al., 2020b). For the purpose of our study, only children who score on and below the 15th percentile of the total impairment score or the manual dexterity section of the MABC-2 will be included in the intervention group. According to the MABC-2 guidelines, a score below the 15th percentile indicates motor skill

impairment as used in other studies (Bonney et al., 2017; Dewey et al., 2011; Ferguson et al., 2013; Maharaj, 2016).

The DCDQ-2 will be completed by teachers at the schools as supportive data, but also to determine concurrent and discriminant validity between the MABC-2 and the DCDQ-2. The DCDQ-2 is an online screening tool which can be completed by parents and/or teachers (Wilson et al., 2009). It is seen as the most reliable screening tool (Blank et al., 2019) to identify motor skill impairment and has been used widely in studies internationally (Chung, 2018; Pek et al., 2009) and in South Africa (Maharaj and Lallie, 2016). The brief questionnaire comprises of 15 questions about a child's execution of tasks requiring gross and fine motor skills. The child should be observed performing the tasks before completion of the DCDQ-2.

Secondary outcome measure

The secondary outcome measure is academic ability. The Kaufman Test of Educational Achievement (KTEA-3-Brief) (Kaufman, 2015) will be administered by the independent researchers. The KTEA (2nd and 3rd edition) has been used successfully in various studies to assess specific elements of academic performance, needs and progress in children (Geoffroy et al., 2010; Hein et al., 2014). The KTEA-3-Brief has three subtests of letter and word recognition, math computation and spelling that can be used as a stand-alone screener for basic academic skills. The estimated time for these three subtests is 20 minutes per child and thus makes it a feasible option for pre-school children.

Other outcome measures

A prevalence study identified gender, playgrounds, fee vs no fee schools, height, and weight of children as confounders to motor skill impairment (van der Walt et al., 2020b). These factors will be included when recording baseline characteristics of schools and participating children. Information about the schools will include socio-economic predictors of the community (fee vs no-fee schools); location (semi-urban vs rural schools); structural elements (playgrounds) and general resources. The height, weight and known diagnoses of learners will be recorded.

Qualitative data will be gathered from the therapist facilitating the programme. The therapist will be asked to keep an electronic diary of his/her experiences, comments received and challenges (Janssens et al., 2018). A list will be provided as guidance for issues to consider and will include resource availability, suitability of playgrounds, accessibility of the schools, safety concerns, teachers' attitudes and contributions, children's motivation and personal motivation and concerns. The qualitative data will enrich the study and provide supportive information in preparation of follow-up feasibility studies (Skivington et al., 2018).

Intervention

The Hopscotch programme aims to develop gross and fine motor skills through an eclectic model of an activity-based body-function oriented approach, while using visual perceptual motor, sensory integration and task-specific training principles. Gross motor sessions will include a warm-up activity, an obstacle course, ball skill game and cool-down activity. Fine motor sessions will include a warm-up activity, craft/other fine motor activity and cool-down activity. The sessions are graded to gradually become more challenging. Activities were chosen to be cost effective and use the

prescribed equipment and materials that should be available at all schools according to the national curriculum statement for foundation phase life skills (Department of Basic Education, 2011).

Ethical aspects

Children will be free to withdraw at any time during the program. Reasons for discontinuation will be recorded on an incident and deviation MS Excel spreadsheet and included in analysis. To improve adherence to the intervention protocol, a detailed manual with descriptions of the activities for each session will be provided. Any deviations from the intervention protocol will be recorded on the incident and deviations spreadsheet. Sessions will take place during school hours when children can be collected by the facilitator for their intervention session. An attendance register will be kept monitoring participant adherence.

Quality control

Interim analysis is not planned as intervention is expected to hold only benefit for all children involved and thus stopping guidelines relating to significance of measured improvement are irrelevant to this study (Shamseer et al., 2015). The trial will be stopped should the safety of the children and researchers be compromised in any way, e.g., COVID-19 exposure, and government guidelines will be followed to safeguard all involved (Department of Health, 2021). The trial will also be stopped if school closures or lockdown procedures are enforced due to a COVID-19 surge (South African Government, 2020). When the trial is stopped, available data will be analysed as far as possible to reach objectives or will be used for future RCT planning. The two independent researchers will be asked to cross-check at least three score sheets at each school during each assessment phase to maintain a consistent standard of evaluation. An external therapist will be asked to visit each of the eight schools once during the intervention process and a checklist will be provided to ensure consistency and quality of intervention. The research assistant will act as monitor to ensure all data are inputted correctly, all adverse incidents are recorded and that confidentiality and blinding guidelines and restrictions remain in place.

Masking

The research staff, who will collect standardised data through means of the assessments, as well as the statisticians, will be masked to the allocation of schools to group 1 or 2. It will not be possible to mask the participants and therapist delivering the programme, however, precautionary measures will be implemented as follows: participating schools will be requested not to disclose to visiting independent researchers whether participating children have received the intervention yet; contact between the masked researchers and intervention therapist will be minimised; masked researchers will have limited access to research data; all unmasking events will be recorded, described and analysed for possible effect (Wenborn et al., 2016).

Data management

Test results will be recorded on the original score sheets and stored safely. The researchers will enter the data into a web-based research folder with custom designed MS Excel Spreadsheets. Researchers will have passwords and identifiers to protect data and masked sections. The accuracy

of data will be audited by a statistician. Personal information will be protected according to the institution and national data protection legislation.

Analysis

Statistical analysis

Baseline characteristic of schools and participants will be presented descriptively. Continuous variables will be reported as means/medians and standard deviation or interquartile ranges, while categorical variables will be reported as counts and percentages. Scores of the MABC-2 at baseline will be used to determine which learners will be included in the intervention groups. The convergent validity of the classification of motor skill difficulty according to the MABC-2 and DCDQ-2 scores will be determined by using the kappa (k-) coefficient (De Milander et al., 2019).

For the primary analysis, scores of the MABC-2 after the intervention at M2 and M3 will be used to determine change within schools, as well as to compare the intervention and control groups at M2 and M3. A linear mixed model (Fitzmaurice and Laird, 2015) in SPSS (SPSS, 2005) will be used to analyse the data. This model allows for the incorporation of random effects (i.e., the schools and repeated measurements), with the fixed effect as the intervention. The same process will be used for the secondary analysis, using the scores of the KTEA-3 BRIEF.

Qualitative analysis

Inductive thematic analysis will be used to analyse the information from the facilitators' diary (Janssens et al., 2018). A six-phased process will be followed as described by Lorelli et al. (2017) to analyse the data including becoming familiar with the data; assigning initial codes; searching for themes; reviewing themes; defining and naming themes and finally reporting on themes. The process will involve at least two researchers and repeated reading to ensure saturation of constructs.

Ethical Considerations

The study has been approved by the Health Research Evaluation Committee and the Ethics Committee of the relevant institution. Ethical considerations include external review, ensuring participant autonomy, maintaining confidentiality and ensuring justice (fair selection of participants). The intervention is of minimal risk and all children at the schools potentially stand to benefit. If a child is thought to have a developmental disorder or delay, a standard letter with basic information about the concern and information about who to contact, e.g., nearest clinic or doctor, will be issued to the school and parents. Children in the control group will participate in the programme as part of the second phase of the pilot programme to create an equal opportunity. Feedback will be given to participating parents and schools and the data will be published in peer-reviewed journals.

Dissemination

The final trial data set will be made available on an open-access database, with all identifying information of participants omitted. The results will be submitted for publication to a peer-reviewed journal and will be presented at national and international conferences. Results will be

communicated to the relevant education department through a summarised report. Participating schools and parents of participating children will receive a report with results and recommendations.

Discussion

This protocol paper presents the background and design of a pilot study to examine the preliminary effect of the Hopscotch programme when delivered by an occupational therapist in the selected schools in a rural, low socio-economical area. Should this intervention prove successful, it is envisaged that the study will be continued and recommendations to the Department of Education will be made for wider roll out. While the pilot project is run by an occupational therapist, the programme was designed to be cost effective and to follow a task-shifting approach, where teachers will facilitate the programme with therapists in an advisory role. The effectiveness of the programme using a task-shifting approach will follow this study. Further research to follow the process, its effectiveness and limitations, is recommended, using the information from the pilot study regarding feasibility, randomisation and blinding, selection of primary outcome measures and calculation of sample size (Skivington et al., 2018).

If integrated into the curriculum, all grade R children are expected to benefit and it is possible that the intervention will have a positive impact on numeracy and literacy competence in general.

Limitations of the Study

Confounding factors such as sport participation, physical education programmes, physical environment and extra-mural activities in the school may influence the outcomes of the study and it will therefore be difficult to predict if the programme will have a similar effect in other schools. The timeframe of when in the school year the programme will be implemented at the two different groups of schools may influence the results, as maturity and exposure may have an influence. However, results may at the same time provide valuable information on when the best time would be to implement the programme.

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Conclusions and Implications

The Hopscotch motor skill programme gives children in rural low socio-economic areas an opportunity to improve their motor skill competence before they start with more formal schooling in the first grade. The programme was developed for children in low socio-economic areas (Van der Walt et al., 2020b). However, it is based on the findings of a scoping review of all pre-school interventions for motor skill impairment, and pre-school children in all areas may benefit. The proposed exploratory RCT should provide guidance about the preliminary effect of the programme on motor skill competence, and early academic progress. The pilot study leads the way for further evaluation and adaptation to the programme.

SECTION 6

DISCUSSION AND CONCLUSIONS

Chapter 7

Discussion

Overview of the Study

This dissertation describes how the researcher used the complex intervention development model to develop a motor skill intervention, Hopscotch, for grade R children on the West Coast of South Africa. The programme was developed through a systematic, yet fluid process of information gathering (prevalence study and scoping review) and modelling through expert opinion (Delphi study). The dissertation ends with a proposal for an exploratory RCT that aims to investigate the preliminary effect of the programme.

A prevalence study confirmed a high incidence of motor skill impairment among pre-school children on the West Coast at 14.5%. This study highlighted an urgent need for intervention, while also identifying important factors influencing motor skill competence among the children in the study. This included the influence of lack of playground equipment on fine motor skill competence, an aspect that would subsequently form an integral part of the Hopscotch programme. The prevalence study further sensitised the researcher to the unique needs of government schools on the West Coast, and the resources available for a future intervention programme.

The first level of the theory-base for the intervention programme was formed through the scoping review that focussed on motor skill interventions for pre-school children. This review identified the most frequently used models of practice, approaches, role players, dosage elements and activities used in motor skill interventions. A broad proposed framework of these components was developed (Van der Walt et al., 2020a) with a suggested "filter" of location, environment and resources to consider when planning an intervention. Filtering enables therapists to select the aspects from each component that are most relevant for their location, environment and available resources. This means that children in LMIC are more likely to benefit from the interventions identified through the scoping review.

A three-phase Delphi study was then conducted to refine the broad framework to specific recommendations for a motor skill intervention programme for children enrolled in schools on the West Coast. Delphi study participants agreed on a small-group, school-based intervention facilitated by teachers with a motor skill specialist such as a therapist or kinderkineticist in a supervisory/advisory role. An 8–12 week programme with two sessions

of 45 minutes was recommended, using a perceptual motor approach and indirect advisory intervention through regular physical education and classroom activities. The recommendations from the Delphi study were refined further by considering other recent reviews (Blank et al., 2019; Preston et al., 2017; Smits-Engelsman et al., 2018), the grade R curriculum (Department of Basic Education, 2014) and socio-economic factors of the community (West Coast District Municipality, 2012). The development stages of the programme are described in Table 5.1Table_51 .

The end product is the Hopscotch motor skill programme, a school-based group intervention, where teachers, through training and with the support of a therapist, will facilitate intervention. An eclectic approach (Ikiugu & Smallfield, 2011) is adopted using a body-function oriented approach with visual-perceptual motor, sensory integration and task-specific training principles. The programme is planned to fit into the usual school day as part of the Life Orientation curriculum. A protocol for the exploratory RCT to assess the preliminary effects of the programme serves an open end to the dissertation, as it is the first step towards the implementation and evaluation of the programme.

Prevalence of Motor Skill Impairment

The prevalence study is, to the researchers' knowledge, the first study in South Africa to focus on motor skill impairment prevalence among grade R learners. Furthermore, as there is no prevalence data available in South Africa or Sub-Saharan Africa for "hidden" developmental disabilities for any age group, our prevalence figures, which includes many possible causes or diagnoses, is a starting point to highlight the need for further investigation into the extent and aetiologies of motor skill impairment in children.

For this study, the prevalence data confirmed the need for motor skill intervention for pre-school children in the West Coast area. The problem was outlined and described through test results and influencing confounding factors. The high prevalence of general motor skill impairment at 14.5% was comparable to similar studies in other low socio-economic areas, with fine motor skill impairment even higher at 24.6%. With clear links evident between motor skills and academic performance (Botha & Africa, 2020; Cameron et al., 2016; Cheng et al., 2011; Harrowell et al., 2018; Piek et al., 2006), the prevalence figures provide some insight into the underlying causes of academic difficulties experienced by South African children (Venter & Bham, 2003). However, this should also be seen in conjunction with high

prevalence rates of FAS in South Africa and specifically the West Coast (Olivier et al., 2013), where cognitive ability may also play a role (Adnams et al., 2001; O'Leary, 2004).

The factors associated with motor skill impairment, and in particular fine motor skill impairment in the prevalence study, were related to challenges faced in low socio-economic areas. Firstly, the extent of playgrounds was associated with poorer fine motor skill development and the study adds to the evidence base that identifies and describes the benefit of playgrounds (Broekhuizen et al., 2014; Delidou et al., 2015; True et al., 2017; Van Jaarsveld, 2018). Secondly, low weight and shorter stature were associated with poorer fine motor skills. It is important to consider that growth delay is also associated with FAS (Kyllerman et al., 1985). Up to date, research mainly focussed on the impact of obesity on motor skills in children (Castetbon & Andreyeva, 2012; Draper et al., 2017). This points to a need for more research on the effect of low weight and shorter stature on motor skill development. Lastly, no-fee schools were associated with poorer fine motor and balance skills. No-fee schools reflect a community's level of income, unemployment rate and level of education (West Coast District Municipality, 2012).

There are many factors contributing to low academic achievement and school drop-out (Entwisle et al., 2005; Venter & Bham, 2003) which may impact on the academic achievement levels and future opportunities for children. The high prevalence of motor skill impairment on a pre-school level may be a contributing factor to poor academic progress on the West Coast. The prevalence study highlights aspects to consider not only for grade R learners, but for a community to improve school readiness, school attainment and a better future for children. The data from the study and recognition of contributing factors, helped to create a background for the next steps of the study at the time of conclusion. It is, however, important to consider the fact that the prevalence data originates form the study done in 2015/2016.

Although there were no significant changes noted in the socio-economic status of the West Coast area, nor the provision of therapy services during the time of the study, the changes during the 2020/2021 time period, with the influence of the 2020 COVID-19 pandemic lockdown regulations (South African Government, 2020), are yet to be determined. Children were unable to attend school for at least four months, after which a phased approach was launched to re-admit pupils to school. In South Africa, grade R and pre-school children were the last to return to a school environment after the lockdown period of 2020. While it may be

the case that children had more time for free-play and gross motor play, many children were confined to small living areas and did not have access to outdoor physical play areas. In fact, children in rural low socio-economic areas of South Africa had been found to be less physically active than international normative levels prior to the COVID-19 pandemic (Minnaar et al., 2016). Lack of playgrounds in poorer communities and safety concerns where there are playgrounds available were found to limit play opportunities for children aged 6–11 in a poorer community of South Africa (Prinsloo & Wilson, 2017). The researcher expects that, subsequently, motor skill impairment prevalence will be even higher in 2021, especially in poorer communities. It also needs to be considered that the grade R class of 2020 may be at a disadvantage when starting grade 1 due to a lack of stimulation and preparation towards school-readiness. This could have a long-term effect on the social-emotional development of children through their school years (Sabol & Pianta, 2012).

Development of a Theoretical Foundation

The scoping review followed the prevalence study to identify key features of interventions to improve motor proficiency in pre-school children. These key features consisted of a mix of traditional and novel approaches and concepts, which were adapted into a proposed framework of components to consider for intervention planning. More traditional process-orientated approaches such as sensory integration and visual-perceptual motor approaches were most commonly used in studies included in the review (Bond, 2011; Sugden & Dunford, 2007). This was followed by the more contemporary functional task motor training approach and indirect approaches of therapists delivering an advisory service or programmes through physical education and classroom activities.

The researcher hypothesised that these named approaches cannot stand alone when developing a complex intervention and are compatible in combination to create a well-defined, yet fluid eclectic approach (Ikiugu & Smallfield, 2011) for a specific cohort. Children with motor skill difficulties are in need of therapy to address their motor skill impairment, yet their environment, resources and individuality need to be considered. An eclectic approach, according to Ikiugu and Smallfield (2011), allows the therapist to choose an OMP together with SMP through clinical reasoning. Reynolds et al. (2017) similarly suggested that therapists look beyond a single approach such as ASI for sensory processing or integration difficulties, but rather suggested a multifaceted model where consideration is given to the aspects of environmental support and resources, intervention role-players (i.e.,

parents or teacher involvement) and treatment approach (i.e., sensory integration, cognitive approaches, etc.) (Reynolds et al., 2017). In this way, therapists can provide comprehensive input to address concerns, while enhancing occupation and participation. However, to achieve this balance, eclecticism needs to be based on a sound understanding of theoretical approaches and a structure to underpin eclectic reasoning. When the term is misused, it becomes a general description, over-used by therapists who feel limited by assigning a single approach to their practice (Ikiugu & Smallfield, 2011).

Occupational therapists, physiotherapists, kinesiologists, teachers and parents were identified as role players, often through multidisciplinary working. This is a relatively small team of role players, considering the wide range of difficulties associated with motor skill impairment (Allison et al., 2007; Dewey et al., 2002; Lingam et al., 2012; Ming et al., 2007; Piek et al., 2000; Pratt & Hill, 2011;Visser, 2003). With the onset of the study, the researcher envisaged a larger intra-disciplinary focus in preparation for a comprehensive intra-disciplinary programme; however the scoping review searches did not reveal national or international studies describing interventions from a wider team. While the involvement of a larger team has been noted (Forsyth et al., 2008), available studies focus on elements of treatment and a wider diagnostic description, rather than specific impairments such as motor skills (Barrett, 2009). Barret (2009) describes the benefits of behavioural vision therapy for DCD, however, the information is nested well within the paper and would not be picked up by the keyword of the scoping review search. The scoping review resulted in a shift of focus, from a wider multidisciplinary group, to a more limited group of therapists, movement specialists, and educators.

Of the 45 studies included, only two studies from LMIC met the criteria for the scoping review, with only one study from South Africa. Conditions in LMIC, and South Africa in particular, offer challenges with regards to the aetiology of motor skill impairment not necessarily experienced in high-income countries (HIC) (Ferguson & Jelsma, 2009; May et al., 2017), rurality (Bateman, 2012; Prakash et al., 2014; Roots et al., 2014) and resources (Ned et al., 2020; Sonday et al., 2012). It was therefore important to consider findings with caution when applying these to the development of a programme for a LMIC.

Refining the Intervention

Expert opinion and consensus were required to refine the components of motor skill intervention for pre-school children as identified in the scoping review, towards more specific

recommendations for the West Coast area. Delphi study participants were experts in the field of motor skill intervention. They considered the information from the scoping review, as well as the general information about the geographical location (West Coast), description of the communities and schools and available resources to respond to questions regarding the details required for an intervention for the specific area. Drawing from the scoping review outcomes, these experts were invited to participate according to the categories of therapy (occupational and physiotherapy), kinesiology (kinderkineticist) and education (teachers with and without physical education qualifications). They included practitioners and teachers working in the field, and academics (researchers and lecturers). The definition of "experts" for this study was considered against participants' level of expertise, years of practice, postgraduate qualifications and publications. Furthermore, participants were invited from all the provinces in South Africa as well as internationally, from both rural and urban areas and within different socio-economic environments.

The aspects considered for decision-making when compiling the questions for the surveys, concur with the proposed framework of components to consider when developing an intervention as suggested in the scoping review (Van der Walt et al., 2020a). This is a good example of the function of the framework. In the complex intervention process (Skivington et al., 2018), the Delphi study results showed a clear shift towards a school-based intervention as Delphi study participants considered the rurality and socio-economic background of the West Coast described to them. A systematic review by Eddy et al. (2019) that looked at the effectiveness of school-based motor skill interventions for 3–12-year-olds, recognised the need for alternative therapy approaches outside a clinic setting where resources are often limited. In this systematic review, interventions focussed more on fundamental movement skills, rather than motor skill impairment, especially with pre-school children (Eddy et al., 2019). In this Delphi study, the focus was on treatment intervention for pre-school children with impaired motor skills. The elements were depicted carefully to enable a clear description of the components which would define the proposed motor skill intervention.

Most school-based interventions included in Eddy et al.'s (2019) systematic review were teacher-led. The outcomes of the Delphi study propose that a therapist-led, yet teacher-facilitated model could be a feasible option for an intervention. This model suggests a task-shifting approach, where therapists act as advisors to teachers as facilitators of the intervention and use functional school-related tasks that already form part of the curriculum

(Table 5.1). The task-shifting approach has mainly been used in the implementation of community programmes to address HIV/AIDS in the shortage of health professionals (Busza et al., 2018 ; Dambisya & Matinhure, 2012; World Health Organization, 2008; Zulliger et al., 2014) and also within paediatric HIV/AIDS care (Marotta et al., 2018). It is not a new concept, and was implemented in African countries as early as 1918 (Baine et al., 2018).

Task-shifting can take place at different levels – in a Ugandan study, for example, clinical duties were transferred from medical specialists to non-clinician colleagues, e.g., from nurses and midwives to nursing assistants and from health workers to the patients themselves or relatives of the patients (Dambisya & Matinhure, 2012). The Delphi study suggests that the facilitator of the intervention could be an occupational therapist, physiotherapist or teacher with PE experience, dependent on availability of resources. A task-shifting model for motor skill interventions in school would rely on the transfer of skill to teachers who are well-qualified to work with children in groups and have foundation knowledge of motor skill development (Stellenbosch University, 2020; University of Pretoria, 2020).

The study by Dambisya and Matinhune (2012) describes barriers to task-shifting in Uganda, which should be considered in any area or intervention. This included reluctance to change; protection of professional territory; professional boundaries; heavy existing workload; poor organisation and planning; lack of clear guidelines and the term "task-shifting" itself. The success of a task-shifting approach greatly depends on organisational factors and leadership as well as stakeholders' understanding of the implication of the intervention (Iwelunmor et al., 2017). An Ethiopian study gives insight into a paediatric-based model with educational and health involvement (Dorsey et al., 2019). In this study, teachers and healthcare workers as the "lay counsellors" delivered a mental health programme to children and adolescents, and the initial success of the project was attributed to the high level of acceptability, feasibility and appropriateness experienced by the "lay counsellors". Although the Delphi study contributes to the content and structure of a proposed intervention, a task-shifting approach would need further investigation into the national educational policies and school structures, stakeholders, feasibility level of an intervention and acceptability and perceptions of educators to shift and extend professional boundaries.

The Delphi study was particularly beneficial with regards to dosage elements of the intervention. While reviews show a wide range of dosage parameters for motor skill intervention (Blank et al., 2012; Smits-Engelsman et al., 2018), consensus was reached by

Delphi study participants to recommend an 8–12 weeks programme, with two sessions per week for 30–45 minutes per session. The Delphi study provided a good basis of recommendations for the development of a programme, while Delphi participants' comments provided valuable insight into the complexity of group interventions in an inclusive environment. Uncertainty remains about the benefits and disadvantages of inclusivity of intervention groups in a school environment and further research into this area is suggested.

The Delphi study was concluded in April 2020 with the onset of lockdown and school closures in many areas. At that stage, the extent of the COVID-19 pandemic was unclear and continued long-term school closures were not expected. It is expected that the outcomes of a Delphi study one year on would have been influenced by new perspectives and experiences by experts in the light of the COVID-19 pandemic. With new waves of infections, more school closures are expected, and with uncertainty about vaccine provision in African countries (Krippahl, 2021), the situation may continue for years rather than months. While the basic components of the intervention would remain, reconsideration needs to be given to the meaning of "school-based" which over the past year has become a virtual, distance-learning concept to many, while others had no access to school at all (Hageman, 2021).

The Hopscotch Motor Skill Intervention Programme

The Hopscotch motor skill intervention programme is the result of emerging recommendations as concepts developed from the scoping review to the Delphi study, also influenced by past and recent research studies, environmental and socio-economic factors, available resources and the South African grade R curriculum (Table 5.1, Chapter 5). The content and structure of the programme aim to provide a high-quality intervention within the resource means and curriculum of government mainstream schools in South Africa. It is based on evidence established by expert contributions towards an intervention for low socio-economic areas through the Delphi study (Boulkedid et al., 2011), in the absence of LMIC studies included in the scoping review.

The common thread from reviews and other studies is that any intervention is better than no intervention and that most interventions have a positive impact on motors skill proficiency (Hillier, 2007; Riethmuller et al., 2009; Smits-Engelsman et al., 2013). From these findings, the researcher summarised the common components of interventions suitable for intervention in a low socio-economic area and had these validated by several experts in the field.

The essential components to ensure feasibility and sustainability of the programme as a task-shifting model include a reliable and consistent screening tool, a thorough training process with a clear manual and guidelines for facilitators and advisors, community involvement and close collaboration between education and health departments (Camden et al., 2015; Dambisya & Matinhure, 2012; Missiuna, Pollock, Campbell et al., 2012; Ratzon et al., 2009). Resources and workload of teachers as well as teachers' and therapists' perceptions about task-shifting need to be considered in close collaboration with the education department and individual schools to avoid possible pitfalls (Dambisya & Matinhure, 2012).

The elements of the eclectic approach and application by approach or principles to the Hopscotch programme can be viewed in Table 5.2, Chapter 5. This was a complex process of data analysis through the scoping review, recommendations considered from the Delphi study, and an in-depth literature review of motor skill intervention approaches, considered against the grade R curriculum requirements and restrictions. The end result was an activity-based body-oriented approach incorporating visual-perceptual motor, sensory integration and task-specific training principles.

The influences of the four professional domains, as indicated through the informative phases of the scoping review and Delphi study, can be seen in the development of the approach. Throughout this study, these domains often overlap in studies and systematic reviews (Anaby et al., 2017). Kinesiology and education-based studies and role players most often focus on fundamental movement skills within a school environment predominantly using visual-perceptual motor and task-specific training approaches (Blank et al., 2019). Physiotherapy studies showed an inclination towards task-specific training, with elements of neuromotor task training and visual-perceptual motor approaches (Ferguson et al., 2013; Lowe et al., 2015; Niemeijer et al., 2006). Occupational therapy studies often combined approaches but mostly included visual perceptual-motor, sensory integration and task-specific training elements (Smits-Engelsman et al., 2018). Recent occupational therapy and physiotherapy studies include a body-function oriented approach as effective (Lowe et al., 2015; Smits-Engelsman et al., 2018). A systematic review for DCD interventions, used in Blank et al.'s (2019) recommendations, suggested a body-function oriented approach with an activity base as a functional approach (Blank et al., 2019). This is adopted for the Hopscotch programme, with a body-function oriented approach as OMP of the eclectic approach, but including

sensory integration, visual-perceptual motor and task-specific principles as CMPs (Wilson et al., 2009).

The screening process is an essential part of the intervention in a country and area where many children remain undiagnosed due to the "hidden" nature of motor skill impairments and lack of resources (Camden et al., 2015). The Developmental Coordination Questionnaire (DCDQ) (Hammell & Iwama, 2012) is seen as a reliable free online standardised screening tool (Western Cape Government Education, 2019), however, further investigation and research are needed to adapt the tool to be culture-specific. The DCDQ-2 may also need to be translated to Afrikaans, which is the main language of the West Coast area. Because of these limitations, the Movement ABC-2 was used as the primary outcome for the exploratory RCT. A benefit of the DCDQ-2 is that it can be administrated by parents and teachers, thus provides room for adaptation of how and where the programme is executed (Craig et al., 2019). Where internet access is not available, the screening questionnaire can be used and/or distributed as a printed copy.

The intervention focuses on play as the main activity, with gross motor and fine motor goals in separate sessions. The choice of activities was informed by the scoping review and Delphi study, however, also drew from the researchers' experience as an occupational therapist and influences recognised during the prevalence study. While conducting the assessments at the sample schools, the researcher noted the discrepancy in the different schools' play environments, which was subsequently noted and analysed as a significant influencer of fine motor skill proficiency (van der Walt et al., 2020b). A core assumption in occupational therapy practice is that participation in occupation influences a person's well-being, while opportunities for participation are influenced by environmental factors (Hammell & Iwama, 2012). The inclusion of a playground element (jungle gym) as part of the baseline equipment for the Hopscotch programme enables and empowers schools and communities to improve opportunities for physical play and motor skill development.

The Hopscotch motor skill intervention has been developed as a school-based intervention for children with motor skill impairment. The structure of the programme fits into and supports the Life Orientation curriculum, and the 12-week timespan fits well within the first and second terms of a traditional school year (Western Cape Government Education, 2019). While future periods of lockdown, school closures and staggered attendance arrangements may impose challenges in the implementation of such a programme, the Hopscotch

programme is adaptable and may be able to function as an online or correspondence programme. This will require the involvement of communities, parents and teachers and clear guidelines will be paramount.

The Next Step: Exploratory Randomised Controlled Trial

The protocol for the exploratory RCT describes a stepped wedge cluster randomised trial to be executed on the West Coast. It is envisaged that the RCT will provide data and recommendations about the preliminary effectiveness of the programme, while proposing further feasibility studies and RCTs as needed as part of the complex intervention development (Craig et al., 2019). Data from standardised assessments will provide information about the initial impact of the programme on motor skill development and academic progress for grade R children. The assessment of academic skills alongside motor skill proficiency is imperative (Eddy et al., 2019) due to the consistent evidence of the link between motor skill development and early academic skills (Botha & Africa, 2020; Cameron et al., 2016; Pienaar et al., 2014; Roebers et al., 2014) and may provide valuable insights and community awareness into the role of motor skill proficiency in school-readiness of grade R children on the West Coast. The exploratory RCT provides opportunity for concurrent and discriminant validity testing between the DCDQ-2 and MABC-2 in preparation of further RCTs to evaluate the intervention as a task-shifting approach.

The exploratory RCT is planned to be a post-doctoral project and will require collaboration between the research team, Western Cape Education Department, schools, parents and the community. At this time, it is uncertain when the pilot study can be completed due to challenges and restrictions imposed by the COVID-19 pandemic. It is, however, envisaged that the community and schools will benefit from associated components of the intervention from the onset of the pilot stage of the project. Community participation will be encouraged to assist in the provision of equipment, e.g., jungle gyms and physical play equipment required for the programme where not in place. The playground additions will be a permanent asset to the school and the community and all pre-school children are expected to benefit. Community involvement may also raise awareness about the early recognition and impact of motor skill impairments.

Limitations of the Study

The limitations of the study need to be acknowledged and will be addressed according to each phase.

Limitations of the Prevalence study

The prevalence study was limited in size (n=138) due to restricted research resources available with regards to researchers and time. The researcher alone carried out the assessments at four schools in remote areas, while final year occupational therapy students completed the assessments at two more schools. It was, however, beneficial for the researcher to stay over and learn more about socio-economic and environmental factors of the rural communities in which schools were located (Hammell & Iwama, 2012).

The MABC-2 is used globally as a reliable diagnostic test for motor skill impairment (Dewey et al., 2011; Blank et al., 2019), however is a UK validated test (Henderson et al., 2007) and has not been validated for culture-specific use in South Africa, which may affect reliability of the prevalence data. Some data were not captured because the forms were not labelled and were omitted at one of the schools. This meant the child's participation in extra-mural activities, previous therapy intervention and repetition of grade R year unfortunately were not utilised in data analysis. This was an administration and communication error which could have been preventable through better organisation and management. Although the research was conducted in close collaboration with the students and their supervisor as co-researchers, a written protocol and guide could have eliminated errors and loss of data.

Limitations of the Scoping Review

Repeated feedback was received from reviewers and advisors during the PhD process about the choice of conducting a scoping review rather than a systematic review and meta-analysis. This would have added depth to the study by adding evidence-based recommendations (Munn et al., 2018), while the scoping review is an overview of the components of motor skill interventions for pre-school children, without a quality measure. This may cause concern about the effectiveness of interventions considered for the framework including approaches, models and or structural elements.

Similarly, role players and their contribution to intervention effectiveness were not interrogated further herein. The possibility of a systematic review was considered, however was complicated by the fact that only two studies included originated from LMIC. The scoping review used the National Health and Medical Research Council (NHMRC) hierarchy of evidence (Merlin et al., 2009) to classify studies which provided more information about level of evidence of studies included in the scoping review. The NHMRC hierarchy identified a lack of high quality RCTs and systematic reviews of RCTs in the literature for motor skill interventions for pre-school children with no included studies qualifying at the highest level (level I). Eight studies qualified as level II studies, where evidence was obtained from at least one RCT. The scoping review did draw from evidence-based studies by summarising and categorising important factors of each study, not covered through the analysis, in a statement box as summarised evidence-based recommendations (Box 1, Chapter 3).

Another limitation of the scoping review was the time-lapse since the first analysis in 2016 to the publication in 2020. The scoping review paper was rejected three times before being accepted for publication in 2020. The researcher believes that the process of publication rejections with accompanying critique inspired many improvements to the study (Sullivan, 2015), one of which was an update of the scoping review in 2019. The framework of proposed components of an intervention and a more specific outlook towards low socio-economic areas were further important elements of the study which were inspired by comments from journals' peer reviewers. A disadvantage to the time-lapse from initiating the scoping review to publication was the declining novelty of the topic of motor skill intervention reviews, with similar studies emerging (Eddy et al., 2019; Han et al., 2018; Preston et al., 2017; Smits-Engelsman et al., 2018; Ward et al., 2017). This scoping review is, however, unique in the sense that it includes a range of conditions associated with motor skill impairment and not only Developmental Coordination Disorder (DCD), as in the case with systematic reviews by Preston et al. (2017) and Smits-Engelsman et al. (2018). While Eddy et al.'s (2019) systematic review focuses on school-based interventions, this scoping review included all interventions, including different therapy venues.

The use of a custom designed MS-Excel worksheet as database for analysis was restricting and time-consuming due to the researchers' limited experience with MS-Excel at the onset of the analysis. A search and review reference database such as Covidence (Covidence, 2020) would have improved the effectiveness of the analysis. The exclusion criteria of the scoping

review restricted the inclusion of unpublished works which may have included more studies and intervention information from LMIC, which was underrepresented in the results of the review (Anderson et al., 2020). The results were further limited in the richness of a wider multidisciplinary team concerned with motor skill interventions. This indicated a need for more research about the involvement of role players such as psychologists, nutritionists, paediatricians, speech, language and hearing therapists, etc. One way to address this issue would be to explore the core-interdisciplinary expert group's opinions and suggestions with regards to other important team members' and their involvement as part of the Delphi study. This could be pursued as a separate study in the future.

Limitations of the Delphi study

The Delphi study was halted at the onset of the second round due to a lapse in an annual ethical renewal review application. The researcher was at fault for this serious oversight in not submitting the review progress report on time (Bain, 2017). On realisation, the HREC was informed immediately, and the Delphi study closed on the Checkbox survey server. A formal letter of apology and explanation and amended protocol with cover letter was submitted to the HREC. Amendments included the additional steps that would be taken to ensure ethical sound continuation of the study, i.e., explaining the lapse to Delphi participants, requesting their re-consent for participation (Appendix 18)Appendix 18: Re-consent letter to Delphi participants (email) and adapting data from the first round to only include the responses from participants who re-consented. Permission to continue with the study under the above restrictions was subsequently obtained from the Health and Research Ethics Committee (Appendix 17) Appendix 17: Ethics approval letter following lapse in ethics approval. Fortunately, no serious negative implications were expected due to the nature of the study, i.e., a survey completed by professionals about professional practice, rather than, for example, addressing personal issues of a more vulnerable group. Nevertheless, the researcher understood the gravity of the situation, and the negative effect that such a mistake can have on the integrity of the study and the confidence and trust of study participants (Artino et al., 2019). Fortunately, only three participants from the first round failed to re-consent and the study continued.

Failure to renew ethical clearance can cause serious delays or completely halt a study. This holds subsequent implications for the participants (expectations and time), the institution (integrity and financial), as well as the researcher (personal development and career) (Bain,

2017; Barrow & Brannan, 2020). This was a valuable lesson about the importance of organisation and forward planning when conducting a study.

Task-shifting was not included as a topic in the Delphi study questionnaires. Experts' comments on their perception of the meaning and value of a task-shifting model, implication for workload in their experience, and professional concerns would have added valuable information to the study and the intervention development stage (Dambisya & Matinhure, 2012; Iwelunmor et al., 2017). The concepts could have possibly been added at stage 3 of the Delphi study following initial analysis of the first two rounds when the concept emerged. Although task-shifting was not directly mentioned by participants, the concepts were implied through the combination of the role players and structural elements suggested. The impact of and perceptions about a task-shifting approach can be further explored during evaluation phases of the intervention development (Brady et al., 2011; Cathain et al., 2019).

Although agreement was reached sufficiently to design the programme, agreement was not reached on who to include in a treatment group and the formulation of group/individual or general developmental aims. Few studies look into the inclusivity of groups as comparative factors. The impact of different service delivery models, with and without inclusive groups, on the visual-motor integration skills in a school environment was explored by Ratzon et al. (2009). The study concluded that all three models delivered similar positive results. The models used were a direct treatment model where children attended individual sessions, a collaborative-consultation treatment model where integrated techniques were used with all the children in the class, and a combined-services model (Ratzon et al., 2009). The comments of the Delphi study participants reveal an uncertainty among experts about issues of inclusivity such as labelling, benefit opportunities for all, children with difficulties standing out, children without difficulties feeling bored, and not leaving any child behind. Availability of resources and the emotional and social well-being of the children were the main concern in decision-making. The comments of the Delphi participants opened research opportunities in the exploration of the inclusivity of research groups.

Limitations in the Development of the Hopscotch Programme

The design of the Hopscotch motor skill intervention programme was limited by the availability of therapy resources in the area (Fourie, 2020, email correspondence, November 9, 2020) and a restricted range of materials and equipment as described in the curriculum guidelines (Department of Basic Education, 2011a). The researcher faced the reality of

limited playground and equipment resources in schools, often not meeting the minimum requirements as prescribed (Broekhuizen et al., 2014; True et al., 2017; Van der Walt et al., 2020b). It was, however, important to work within the constraints of the resources to ensure a feasible programme. The limitations also create opportunities for community involvement which may help to make the programme more sustainable (Dambisya & Matinhure, 2012).

Although the DCDQ-2 was established as a reliable and feasible screening tool to be used pre- and post-intervention (Pek et al., 2009; Wilson et al., 2009), uncertainty remains about the cultural and language implication for children in South Africa (De Milander et al., 2019; Venter et al., 2015). Further investigation into cultural adaptations and translation of the DCDQ-2 will not only benefit the Hopscotch programme, but it is envisaged that it could improve early identification of motor skill impairment. Studies of validation prior to, or embedded within, the pilot study are recommended and may be a research opportunity for a Master of Science degree in the fields of occupational therapy, physiotherapy or kinesiology.

The exploratory trial of the Hopscotch programme is expected to reveal further limitations and challenges of the programme. This is seen as a positive effect within the complex intervention development model and reflects the fluidity and continued refining of programme development (Craig et al., 2019).

Limitations of the Exploratory Randomised Controlled Trial

A protocol for an exploratory RCT has been drafted, but still needs to be finalised. The protocol will also need to be reviewed for continued ethical approval. Changes were made to the original protocol to allow for research advances through the intervention development process. Changes in research policies within the education department will also be considered in the light of the COVID-19 pandemic. The project faces uncertain delays at the moment amid the pandemic, as it is dependent on the attendance of the grade R children of the sample schools for at least twice weekly for a 12-week period initially, followed by a further 10 weeks. The funding of the project and recruitment of researchers are aspects that also need to be considered timely.

Limitations of the Overall Research Process

As a staged study, the delays in the individual stages of the study had an overall delay-effect on the complete study. However, the framework of complex intervention planning assisted in creating a consistent and fluid development of the intervention through the stages (Craig et

al., 2019). The different methods used contributed to the richness of the study as qualitative aspects complimented quantitative data and compensated for some of the limitations experienced in understanding the outcomes (Kroll & Neri, 2009; Maikranz et al., 2017). Richards et al. (2019) proposed that the application of mixed methods integration techniques may improve the understanding of the outcomes of RCTs. This will enable integrated display tables and would, for example, also be useful for the Delphi study to view the participants' comments against areas of consent and dissent (Richards et al., 2019). Applications of the techniques could be considered for the exploratory RCT and further evaluation studies.

Summary

The Hopscotch motor skill intervention programme is the result of a phased complex intervention development study. It demonstrates the possibility of a cost effective, feasible, evidence based, inter-disciplinary school-based motor skills programme for pre-school children in a rural low socio-economic setting. It recommends careful use of a task-shifting approach. Preliminary effectiveness and feasibility are yet to be determined. A proposal for an exploratory RCT has been drafted. Given the adaptability of the Hopscotch programme, rolling out this intervention to other schools within the area and also the rest of South Africa is promising.

Chapter 8

Conclusion and Implications

This study suggests that it is possible to reach pre-school children in rural and low socio-economic areas, who would not otherwise have access to the diagnosis of, and interventions for, motor skill impairment. The findings of the study revealed that the Hopscotch motor skill intervention programme may be a feasible solution to address the high prevalence of motor skill impairment among pre-school children on the West Coast of South Africa. The 12-week school-based interdisciplinary intervention adopts a task-shifting model and is designed to fit into the grade R curriculum of government schools. The small-group activities are cost-effective and underpinned by an evidence-based eclectic approach geared towards motor skill improvement and school-readiness.

Contribution to Knowledge

The following aspects are, to the researcher's knowledge, new contributions to the field of motor skill impairment and intervention development for pre-school children:

- The prevalence study contributes prevalence data about motor skill impairment incidence among pre-school children in the West Coast area of South Africa. At 14.5% the prevalence of motor skill impairment in this rural low socio-economic area can be described as high when compared to global figures, with fine motor skill impairment prevalence as very high at 24.6%. The data is transferable to other areas with a similar socio-economic background.
- The factors that significantly impact on motor skill proficiency in this region were gender (male>female); limited playground opportunities; low weight and short stature; and attendance at no-fee schools.
- A proposed framework of components to consider summarises approaches, service-delivery models, role players, structural elements and activities most frequently used for pre-school motor skills interventions in included studies of the scoping review. The scoping review is unique in its focus on interventions for pre-school children

treating any developmental conditions causing motor skill impairment, by any role player and in any venue.

- An updated model (Figure 5.1) developed as the study progressed and is a novel model for use in intervention development in occupational therapy across different fields of practice.
- The Delphi study contributes expert opinion about components of an intervention for the West Coast as a rural low socio-economic area.
- There is a clear shift within the Delphi study towards a school-based intervention with a task-shifting approach with teachers as facilitators and therapists as advisors. This introduces a new model of service delivery within an education environment. Although task-shifting is a common practice in African countries, the proposed model is educational rather than health-based.
- The recommended intra-disciplinary team for a school-based motor skill intervention could include rehabilitation therapists (occupational and/or physiotherapists) or movement specialists (kinderkineticists) and teachers (teachers with or without PE training and teaching assistants).
- Participants' comments revealed uncertainty among experts about the inclusivity of groups and the formulation of aims for a treatment group. This contributes knowledge about the challenges and concerns faced in decision-making when developing school-based interventions.
- The Hopscotch is an innovative motor skill programme that, depending on the outcomes of further evaluations, has the potential to be rolled out to other areas with similar resource constraints.
- The DCDQ-2 is introduced as a possible screening tool for identifying children with motor skill impairment at a pre-school level.

- A new eclectic approach is adopted for the Hopscotch programme as a functional approach, drawing on outcomes from the informative stages of the study, yet considering the latest international recommendations. An eclectic approach with an activity-based body-function oriented approach as OMP with visual-perceptual motor, sensory integration and task-specific training principles as CMP is the preferred approach for the programme.
- The exploratory RCT will provide valuable information about the feasibility of the programme and the preliminary effect on the motor skill proficiency and academic skills of grade R children. It will also lay the foundation for further studies and evaluations of the programme as part of the fluid complex intervention development.

Implications of the Study

Implications for Policy

The possibility of an in-school motor skill intervention within the grade R curriculum opens new possibilities with new protocols for therapeutic service delivery within the education and health systems. Close collaboration between these departments as well as the community and schools at ground-level will be paramount to the success of the intervention. The Life Skills curriculum policy (Department of Basic Education, 2011a) may need to be adjusted to consider motor skill proficiency among children with motor skill impairment. It is imperative that, in an inclusive education system (Republic of South Africa, 1996), policies do not only focus on typical development but also on recognising and addressing barriers in development. The outcomes of the prevalence study and exploratory RCT will add value to a proposal to provide the governing education and health departments with the necessary information to consider the intervention as part of the present curriculum.

The prevalence study recognised the importance of gross motor play opportunities through access to playgrounds as an influencing factor of motor skill proficiency (Van der Walt et al., 2020b). This raises concerns about the present COVID-19 regulations in South Africa, with regards to school and playground closures (South African Government, 2020). It is proposed that the regulations be carefully considered with a view to short- and long-term effects on

child development, school readiness and academic progress. Parks and playgrounds can adhere to social distancing procedures and preventative measures such as sanitising stations and regular cleaning, while providing children with access to play opportunities.

Implications for Occupational Therapists

The researcher focussed on implications for occupational therapist as the most frequent role players in motor skill interventions in the South African health and government education system. The availability of a pre-planned intervention programme may significantly reduce the pressure on occupational therapists within these departments to reach and treat pre-school children with motor skill impairments (Ned et al., 2020). Therapists in the education and rural health setting have in fact already adopted more indirect approaches due to a lack of time and resources (Bateman, 2012; Sonday et al., 2012).

A task-shifting approach within the education domain is recommended, where training and guidance for teachers as facilitators of motor skill interventions is emphasised as a role of the occupational therapists. The occupational therapist remains the specialist with regards to motor skill development and treatment management, and a clear referral pathway is very important to ensure that children in need of more intensive interventions do not slip through the net. While the proposed programme potentially allows for therapist to focus on children in need of specialist therapist intervention, it is also important to consider that children, who would previously remain undiagnosed, will now be identified and the need for intervention may well increase with time.

The value of gross motor play and its influence on fine motor skills, as indicated by the prevalence study, highlights the value of playgrounds within pre-school environments to enhance motor skill proficiency. Occupational therapists are encouraged to develop an awareness of school environments and playgrounds in order to collaborate with communities to ensure all children have an opportunity for gross motor play as part of motor skill proficiency development (Hammell & Iwama, 2012). On a pre-school level, the researcher suggests that an approach focussing on body-function development, but which is activity- and functional-based, is important to enhance motor skill proficiency as part of school readiness.

The updated framework of components for intervention development may assist occupational therapists in intervention planning across all fields of practice and in different scenarios.

Implications for Education

Research indicates that motor skill development influences academic progress and school readiness (Botha & Africa, 2020; Cameron et al., 2016; Dewey et al., 2002; Ericsson, 2008; Sherry & Draper, 2013; Wilson et al., 2013). The Hopscotch programme aims to empower teachers to identify children with motor skill impairment and offer an intervention within the usual school curriculum, which may better prepare children for formal schooling and grade 1. The programme requires willingness and adaptability from schools and grade R teachers to take part in the training, screening and facilitating process of the programme. Support through close collaboration provided by the leading therapist, is essential (Dambisya & Matinhure, 2012). This would better be established if the leading therapist fulfilling the advisory role is familiar with educational policies and procedures, but also the specific challenges teachers may face in their individual schools and communities. As such, where possible, therapists local to the region in which schools are located should be considered as advisory role players.

Once the final structure of the programme has been established, it will be presented to the education department. Should the programme be integrated as part of the curriculum, it would be beneficial to incorporate the programme as part of pre-school and foundation level teacher training. Similarly, the programme could be presented as part of occupational therapy student training with task-shifting principles of training and advisory services as central to the intervention method. The pilot study, further evaluation, and implementation methods of the programme is dependent on the issues related to the COVID-19 pandemic, including research-based access to schools, school closures and attendance policies, as well as the availability of a vaccine in all areas.

Implications for Research

The use of a complex intervention development model (Craig et al., 2019) is recommended for intervention development within health and rehabilitation sciences in Africa. The complex intervention development model (Craig et al., 2019) guides a staged research process, while allowing for fluidity and change as the study progresses through the stages. In this study, it proved valuable to document the changes through the stages as a table (Table 5.1) for transparency of how the process influenced the development of the preliminary programme as end-product. The model allows for continuity, which is particularly important for this PhD study through to the evaluation phases at post-doctoral level. The different methods used in

each stage (Kroll & Neri, 2009) within the complex intervention model provided opportunity for comprehensive integration and interpretation of quantitative and qualitative data. This contributed to the understanding of components considered in each stage, while also merging the interpretation of data through the stages to the preliminary end product.

Further research to continue the complex intervention development is implied and includes the piloting, evaluation and implementation of the Hopscotch programme (Skivington et al., 2018). Long-term follow-up studies of the implications of the programme are recommended to investigate the effect of the programme on prevalence data, and motor proficiency and academic progress attainment in later grades.

Research to further investigate the influencing factors on motor skill proficiency, as indicated in the prevalence study (Van der Walt et al., 2020b), is recommended. These include the effect of playgrounds and weight and height of children on motor skill proficiency. Prevalence studies in other geographical areas and socio-economic environments are recommended as comparative studies. For example, it would be interesting to investigate the prevalence of motor skill impairment in private schools in South Africa, as the smaller class groups may encourage the enrolment of children who experience different barriers in learning.

The scoping review (Van der Walt et al., 2020a) showed a lack of strong evidence in the area of motor skill interventions for pre-school children and there is a need for RCTs and/or systematic reviews of RCTs to support evidence-based practice globally and in South Africa. Research into the roles of a wider multidisciplinary team concerned with addressing motor skill impairments is recommended.

Uncertainty about the inclusivity of intervention groups in a school environment was evident in the outcomes of the Delphi study (Van der Walt et al., in preparation) and further research in this area is recommended. The Developmental Coordination Disorder Questionnaire (DCDQ-2) (DCDQ, 2016) was recommended as a screening tool for use in the intervention (Smits-Engelsman et al., 2018) and further investigation into the translation and cultural adaptation of the DCDQ-2 is recommended.

The impact of the COVID-19 pandemic, with uncertainty around regulations and restriction, will evidently impact on the follow-up suggested research associated with this study.

However, in a changing world, the emphasis should be on adapting methodology and research designs to continue the complex intervention development.

Continued research in motor skill intervention for pre-school children is essential globally, but especially in rural and low socio-economic areas where children are more likely to develop motor skill impairments, yet are less likely to be recognised or to receive the therapy input that they need. The Hopscotch motor skill intervention programme may contribute in the global battle to ensure that no child gets left behind.

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Appendices

Appendix 1: Research timeline

Date	Study component	Event
2014	Prevalence study	Ethical clearance (Appendix 3) (N14/08/109)
2015	Prevalence study	Ethical clearance for minor adaptations (Appendix 4) Data collection starts
2016	Prevalence study	Completion of prevalence study.
	Scoping review	Initial planning of scoping review
2017	PhD study	Ethical clearance (Appendix 2) (S16/10/190)
	Scoping review	Complete first attempt of scoping review paper
2018	Prevalence study	Submit paper to SAJE
	Scoping review	Submit paper to (rejected with recommendations)
	Delphi study	Planning of Delphi study
2019	Prevalence study	Paper accepted for publication by SAJE
	Scoping review	Update of scoping review to include studies up to 2019
		Submit updated paper to Physical and Occupational Therapy in Pediatrics – rejected with recommendations
April 2019	Delphi study	Survey starts (round 1)
August 2019	Delphi study	Halt survey due to lapse in ethical clearance
September 2019	Delphi study	Permission to continue granted by HREC (Appendix 17) Re-consent obtained from participants
	PhD study	Minor adaptations to study accepted by PhD evaluation committee
2020	Prevalence paper	Published by SAJE
	Scoping review	Paper submitted for publication to BJOT– rejected with recommendations
		Paper submitted to AJOD, accepted for publication and published
	Delphi study	Complete study after 3 rounds
		Submit paper to Journal of Disability and Rehabilitation: rejected, not a fit for the journal
		Submit paper to early childhood Education Journal: rejected, not a fit for the journal
	PhD study	Annual ethics review progress report. Ethics approval letter (Appendix 22 Appendix 22: Ethics approval following annual ethics progress report)
	Hopscotch Programme	Design hopscotch motor skill intervention programme
	Protocol for exploratory RCT	Design RCT
	PhD study	Initiate dissertation writing
2021	PhD study	Complete dissertation
2021 +	Delphi study and Exploratory RCT	Submit for publication
	Exploratory RCT	Post-doctoral study

Appendix 2: HREC PHD initial approval

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Approved with Stipulations

Response to Modifications- (New Application)

08-Mar-2017
Van Der Walt, Janke J

Ethics Reference #: S16/10/190

Title: **The development of an early intervention programme to improve motor skills and academic performance of grade R pupils in government schools in the West Coast of South Africa**

Dear Ms Janke Van Der Walt,

The **Response to Modifications** - ***(New Application)*** received on **15-Feb-2017**, was reviewed by members of **Health Research Ethics Committee 2** via Expedited review procedures on **08-Mar-2017**.

Please note the following information about your approved research protocol:

Protocol Approval Period: **08-Mar-2017 -07-Mar-2018**

The Stipulations of your ethics approval are as follows:
1. The informed consent form for the pilot intervention has no place for a witness signature. Please provide space for the witness's signature in the informed consent form.
2. Please provide information about the "reward" in to the protocol.

Please remember to use your **protocol number** (**S16/10/190**) on any documents or correspondence with the HREC concerning your research protocol.

Please note that the HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:
Please note a template of the progress report is obtainable on www.sun.ac.za/rds and should be submitted to the Committee before the year has expired.
The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.
Translation of the consent document to the language applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372
Institutional Review Board (IRB) Number: IRB 0005239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.
For standard HREC forms and documents please visit: www.sun.ac.za/rds

If you have any questions or need further assistance, please contact the HREC office at .

Included Documents:
Parent quiestionnaire for pilot intervention.docx
Informed consent pilot intervention.doc
General Checklist(Eng)_V2.1 April 2016 (3).doc
Investigator Declaration Janke Van der Walt V4.2 (Eng).pdf Janke.pdf
Synopsis.docx
20170127 MOD Informed consent pilot intervention
CV Dr Lyn Thijsse.pdf
Application Form Signatures1.jpg
20170227 MOD2 LETTER_20170209_NEW-Mods2_S1610190.pdf
20170127 MOD Parent questionnaire for pilot
20170227 MOD2 Informed consent pilot intervention. Translateddoc.doc feb 2017.doc
20170127 MOD Movement ABC - 2 Description
20170127 MOD HREC Mods letter
Application Form V9 14 April 2016 (Eng) (1).doc
CV Dr N Plastow.docx
Cover letter.doc
CV Janke Van der Walt .doc
20170227 MOD2 Ethics modifications 2017.docx 2.docx
InformedConsentDelphi.doc
FW_ Janke van der Walt_PhD RE-SUBMISSION.pdf
20170127 MOD Cover letter
CV Dr M Unger.docx
Investigator Declaration NP.pdf
Investigator Declaration_MU.pdf2.pdf
Protocol.docx
20170127 MOD Informed Consent Delphi
Investigator Declaration LT V4.2 (Eng).pdf

Sincerely,

Francis Masiye
HREC Coordinator
Health Research Ethics Committee 2

Appendix 3: HREC approval Prevalence study

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Approved with Stipulations
New Application

13-Oct-2014
Van der Walt, Janke J

Ethics Reference #: N14/08/109

Title: **The prevalence of motor impairment in children in grade R in mainstream public schools in the West Coast district of South Africa.**

Dear Mrs Janke Van der Walt,

The **New Application** received on **18-Aug-2014**, was reviewed by Health Research Ethics Committee 1 via Committee Review procedures on **01-Oct-2014**.

Please note the following information about your approved research protocol:

Protocol Approval Period: **01-Oct-2014 -01-Oct-2015**

Present Committee Members:
Kearns, E
Weber, Franklin CFS
Sprenkels, Marie-Louise MHE
Els, Petrus PJJS
Potgieter, Sunita S
Hendricks, Melany ML
WELZEL, Tyson B
Burgess, Lesley
Barsdorf, Nicola N
Botha, Paul JP
Decloedt, Eric EH
Hall, David DR

The Stipulations of your ethics approval are as follows:
The opening statement in the ICF "You are being invited to take part in a research project" should be changed to "Your child ……."

Please remember to use your **protocol number** (**N14/08/109**) on any documents or correspondence with the HREC concerning your research protocol.

Please note that the HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:
Please note a template of the progress report is obtainable on www.sun.ac.za/rds and should be submitted to the Committee before the year has expired.
The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.
Translation of the consent document to the language applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372
Institutional Review Board (IRB) Number: IRB 0005239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.
For standard HREC forms and documents please visit: www.sun.ac.za/rds

If you have any questions or need further assistance, please contact the HREC office at 0219389657.

Included Documents:
HREC general checklist
Protocol
Letter to Dept of Education
Checklist for parents
Investigator declaration (Unger)
Cover letter
Investigator CV (Van der Walt)
HREC New application form
Protocol Synopsis
Informed consent form
Investigator CV (Unger)
Investigator declaration (Van der Walt)

Sincerely,

Franklin Weber
HREC Coordinator
Health Research Ethics Committee 1

Investigator Responsibilities

Protection of Human Research Participants

Some of the responsibilities investigators have when conducting research involving human participants are listed below:

1.Conducting the Research. You are responsible for making sure that the research is conducted according to the HREC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research.

2.Participant Enrolment. You may not recruit or enrol participants prior to the HREC approval date or after the expiration date of HREC approval. All recruitment materials for any form of media must be approved by the HREC prior to their use. If you need to recruit more participants than was noted in your HREC approval letter, you must submit an amendment requesting an increase in the number of participants.

3.Informed Consent. You are responsible for obtaining and documenting effective informed consent using **only** the HREC-approved consent documents, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least fifteen (15) years.

4.Continuing Review. The HREC must review and approve all HREC-approved research protocols at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period.** Prior to the date on which the HREC approval of the research expires, **it is your responsibility to submit the continuing review report in a timely fashion to ensure a lapse in HREC approval does not occur.** If HREC approval of your research lapses, you must stop new participant enrolment, and contact the HREC office immediately.

5.Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, number of participants, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the HREC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written HREC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the HREC should be immediately informed of this necessity.

6.Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research-related injuries, occurring at this institution or at other performance sites must be reported to the HREC within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the HRECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch Universtiy Health Research Ethics Committee Standard Operating Procedures www.sun025.sun.ac.za/portal /page/portal/Health_Sciences/English/Centres%20and%20Institutions/Research_Development_Support/Ethics/Application_package All reportable events should be submitted to the HREC using the Serious Adverse Event Report Form.

7.Research Record Keeping. You must keep the following research-related records, at a minimum, in a secure location for a minimum of fifteen years: the HREC approved research protocol and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the HREC

8.Reports to the MCC and Sponsor. When you submit the required annual report to the MCC or you submit required reports to your sponsor, you must provide a copy of that report to the HREC. You may submit the report at the time of continuing HREC review.

9.Provision of Emergency Medical Care. When a physician provides emergency medical care to a participant without prior HREC review and approval, to the extent permitted by law, such activities will not be recognised as research nor will the data obtained by any such activities should it be used in support of research.

10.Final reports. When you have completed (no further participant enrolment, interactions, interventions or data analysis) or stopped work on your research, you must submit a Final Report to the HREC.

11.On-Site Evaluations, MCC Inspections, or Audits. If you are notified that your research will be reviewed or audited by the MCC, the sponsor, any other external agency or any internal group, you must inform the HREC immediately of the impending audit/evaluation.

Appendix 4: HREC approval minor adaptations for Prevalence study

Ethics Letter

29-Apr-2015

Ethics Reference #: N14/08/109
Clinical Trial Reference #:
Title: The prevalence of motor impairment in children in grade R in mainstream public schools in the West Coast district of South Africa.

Dear Mrs Janke Van der Walt,

Your application dated 25 March 2015 refers.

The HREC approved the following amendments to the abovementioned research project:

- Additional study staff: students to collect data
Susan Wessels
Mareli du Plessis
Chane Pienaar
Michelle Smyth
Nicole Lamberts

- Revised parent checklist

- Afrikaans Consent Form

If you have any queries or need further assistance, please contact the HREC Office 219389657.

Sincerely,

REC Coordinator
Franklin Weber
Health Research Ethics Committee 1

Appendix 5: WCED letter of approval

Western Cape Government
Education

Directorate: Research

Audrey.wyngaard@westerncape.gov.za
tel: +27 021 467 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20141113-39909
ENQUIRIES: Dr A T Wyngaard

Mrs Janke Van der Walt
PO Box 488
St Helena Bay
7390

Dear Mrs Janke Van der Walt

RESEARCH PROPOSAL: THE PREVALENCE OF MOTOR IMPAIRMENT IN CHILDREN IN GRADE R IN MAINSTREAM PUBLIC SCHOOLS IN THE WEST COAST DISTRICT OF SOUTH AFRICA

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **22 January 2015 till 30 July 2015**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 13 November 2014

Appendix 6: Information and consent letter for prevalence study (English)

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM

TITLE OF THE RESEARCH PROJECT:

The prevalence of motor impairment in children in grade R in mainstream public schools in the West Coast of South Africa

REFERENCE NUMBER:

PRINCIPAL INVESTIGATOR: Dr Marianne Unger

ADDRESS:

CONTACT NUMBER:

Your child is being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff or therapist any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the **Health Research Ethics Committee at Stellenbosch University** and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

…… School has been selected as part of a sample to take part in a prevalence study to determine how many grade R pupils experience significant difficulty with motor skills. Motor skills refer to large and small motor movements needed for skills such as maintaining a good posture, coordination, balance and hand skills. Research indicates that these foundation skills also affect academic skills such as reading, writing and early mathematical skills. If we can determine how many children are affected, further research can be motivated to explore the best possible way to help these children within our public South African schools.

The study aims to assess the motor skills of each grade R pupil whose parents signed a consent form. The test used is a standardised assessment which is used world wide namely the Movement Assessment battery for Children (MABC).The test is administrated individually for each child and comprises of tasks such as catching a beanbag/ball, jumping, pencil and scissors activities. Each assessment takes 20 – 30 minutes and will be administrated by a qualified occupational therapist or physiotherapist at the school. Children usually enjoy the activities and care will be taken to ensure the child is at ease.

Why have you been invited to participate?

All grade R pupils in the selected schools are invited to participate

What will your responsibilities be?

Parents will be asked to complete a short checklist prior to the study

Will you benefit from taking part in this research?

Feedback will be given to participating parents and schools after the study and where children are identified as having significant motor skill impairment, guidance and information will be provided.

Statistics about motor impairment in the schools of the Western Cape will open up the opportunity for continuing research in this area to help ensure children receive the help they need to progress in school.

Are there in risks involved in your taking part in this research?

Activities involve jumping and other simple physical tasks but are done under strict guidance, so limiting any risk of injury. Time out of the classroom will be kept to a minimum and in consultation with the teachers

If you do not agree to take part, what alternatives do you have?

If you are concerned about your child's motor skills but do not wish for your child to take part in the study, please contact your local paediatrician, occupational therapist or physiotherapist for more information to arrange a consultation.

Who will have access to your medical records?

Codes rather than names will be used for participants and the identity of participants will remain anonymous. All data collected will be treated as confidential and will be protected. Only research staff will have access to data. The outcome of the study may be published in a peer-reviewed journal.

What will happen in the unlikely event of some form injury occurring as a direct result of your taking part in this research study?

In any event of a minor bruise or injury, the therapists will follow the school's usual first aid policy.

Will you be paid to take part in this study and are there any costs involved?

No you will not be paid to take part in the study. There will be no costs involved for you, if you do take part.

Is there anything else that you should know or do?

- You can contact Janke Van der Walt at tel 0848655610 if you have any further queries or encounter any problems.
- You can contact the Health Research Ethics Committee at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed by your study doctor.
- You will receive a copy of this information and consent form for your own records.

Declaration by participant

By signing below, I ……..……. agree to take part in a research study entitled: The prevalence of motor impairment in children in grade R in mainstream public schools in the West Coast district of South Africa.

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.

- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (*place*) .....…….. on (*date*) ……....…….. 2014.

....
Signature of participant **Signature of witness**

Declaration by investigator

I *(name)* ……..…… declare that:

- I explained the information in this document to ……..
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter. (*If an interpreter is used then the interpreter must sign the declaration below.*

Signed at (*place*) .....…….. on (*date*) ……....…….. 2005.

....
Signature of investigator **Signature of witness**

Declaration by interpreter

I *(name)* ……..…… declare that:

- I assisted the investigator (*name*) ……. to explain the information in this document to (*name of participant*) ……..…….. using the language medium of Afrikaans/Xhosa.

- We encouraged him/her to ask questions and took adequate time to answer them.
- I conveyed a factually correct version of what was related to me.
- I am satisfied that the participant fully understands the content of this informed consent document and has had all his/her question satisfactorily answered.

Signed at (*place*) .....….....…….. on (*date*) ……...……..

....
Signature of interpreter **Signature of witness**

Appendix 7: Information and Consent letter Prevalence study (Afrikaans)

DEELNEMER INLIGTINGSTUK EN TOESTEMMING VORM

TITEL VAN DIE NAVORSINGSPROJEK:

Die voorkoms van die motoriese probleme in kinders in graad R in die hoofstroom openbare skole in die Weskus van Suid-Afrika

VERWYSINGS NOMMER: N14-08-109

HOOFNAVORSER: Janke Van der Walt

ADRES: Posbus 488
St Helenabaai
7390

KONTAK NOMMER: 0848655610

U kind word hiermee uitgenooi om aan ‘n navorsingsprojek deel te neem. U word gevra om asb. die volgende inligting noukeurig deur te gaan, aangesien dit die details van die projek verduidelik. Vra asb. die navorsings personeel of terapeut as daar enige iets is oor die projek wat u nie verstaan nie. Dit is baie belangrik dat u voel u verstaan wat die navorsing behels en hoe u kind betrokke sal wees. U kind se deelname is heeltemal vrywillig en u is welkom om deelname van die hand te wys. As u sou besluit om nee te se, sal dit u onder geen hoedanigheid u of u kind negatief beïnvloed nie. U kan ook u kind enige op enige tydstip van die projek onttrek, selfs as u nou toestemming gee dat u kind mag deelneem.

Die studie is goedgekeur deur die **Gesondheidswetenskappe Navorsings etiekkomitee** van **Stellenbosch Universiteit** en sal uitgevoer word volgens die etiese riglyne and beginsels van die internasionale Verklaring van Helsinki, Suid Afrikaanse Riglyne vir Goeie kliniese Praktyk en die Mediese Navorsings Raad.

Waaroor gaan die projek?

U kind se skool is gekies om deel te neem aan ‘n studie om te bepaal hoeveel graad R leerlinge sukkel met motoriese vaardighede. Motoriese vaardighede bestaan uit groot en klein bewegings wat nodig is vir vaardighede soos bv. om ‘n goeie postuur te kan handhaaf; te kan spring of hardloop met goeie koördinasie of om ‘n skêr of pen met goeie kontrole te kan hanteer. Hierdie basiese vaardighede kan ook skool take soos bv. lees, skryf en wiskunde vaardighede beïnvloed. As ons weet hoeveel

kinders hiermee ‘n probleem het, kan dit as motivering dien vir verdere navorsing om uit te vind hoe hierdie kinders op die bes moontlike manier gehelp kan word.

Vir die projek, mik ons om elke graad R leerling wie se ouer die toestemmings brief geteken het se motoriese vaardighede te evalueer/toets. Die toets wat gebruik gaan word is gestandaardiseerde en word wêreldwyd gebruik. Die naam van die toets is: The Movement Assessment battery for Children. Elke kind word individueel gesien en word getoets deur take soos bv. om ‘n boontjiesakkie of bal te vang; te spring; te ryg, asook potlood aktiwiteite. Elke evaluasie neem 20 – 30 minute en sal uitgevoer word by die kind se skool deur ‘n arbeidsterapeut of arbeidsterapie student. Kinders geniet gewoonlik die aktiwiteite en die terapeute sal seker maak dat die kinders gerus en gemaklik voel.

Hoekom is u kind gekies om deel te neem?

Al die graad R leerlinge in die klas word uitgenooi om deel te neem.

Wat is u verantwoordelikhede?

Ouers sal gevra word om ‘n kort vraelys te voltooi voordat die studie begin. Die vraelys help ons om te bepaal of daar enige iets is wat die kind se motoriese ontwikkeling kan beïnvloed bv. buitemuurse aktiwiteite waaraan die kind deelneem.

Sal u/u kind baat vind by die studie?

Die skool en ouers sal terugvoer ontvang na die evaluasies en as ‘n motoriese probleem by ‘n kind geïdentifiseer word sal leiding en informasie verskaf word.

As meer statistieke beskikbaar is oor motoriese probleme in skole in die Weskus, mag dit geleentheid skep vir verdere navorsing sodat kinders die nodige hulp ontvang om beter op skool te vorder.

Is daar enige risiko vir my kind?

Die toets bestaan uit aktiwiteite bv. spring, bal spel ens. wat geen groter risiko as alledaagse spel vir u kind inhou nie.

Wat is die alternatiewe as u besluit om nie deel te neem aan die studie nie?

As u bekommerd is oor u kind se motoriese vaardighede, maar verkies dat u kind nie deel nee aan die studie nie kan u die naaste pediater, arbeidsterapeut of fisioterapeut kontak vir meer informasie oor plaaslike evaluasies of behandeling. .

Wie sal toegang he tot u kind se rekords?

Kodes i.p.v. name sal gebruik word en u kind se identiteit sal anoniem gehou word. Alle data sal as konfidensieel beskou word en beskerm word. Slegs navorsings personeel sal toegang he tot die data en informasie. Die resultate van die studie mag in ‘n professionele joernaal gepubliseer word.

Wat gebeur in die onwaarskynlike geval as daar ‘n besering is a.g.v. u kind se deelname aan die studie?

Die terapeut sal die skool se noodhulp prosedure volg as die kind ‘n besering opdoen.

Is daar betaling vir u om deel te neem of is daar enige koste betrokke?

Nee, daar is geen betaling vir deelname nie. Daar is ook geen koste om deel te neem nie.

Is daar enige iets anders wat u moet weet of doen?

- U kan vir Janke Van der Walt kontak by tel 0848655610as u enige vrae het of probleme ondervind
- U kan die Gesondheidswetenskappe Navorsings etiekkomitee van Stellenbosch Universiteit kontak by 021-938 9207 as u enige kwessies of klagtes het wat nie voldoende deur die studie leier hanteer is nie
- U sal ‘n kopie ontvang van hierdie brief en u toestemmingsbrief vir u eie rekords.

Verklaring deur ouer

Ek, ……..…… gee hiermee toestemming dat my kind mag deelneem aan die volgende studie: Die voorkoms van die motoriese probleme in kinders in graad R in die hoofstroom openbare skole in die Weskus van Suid-Afrika

Ek verklaar dat:

- Ek die informasie en toestemmingsbrief gelees het of dat aan my voorgelees is en dat dit geskryf is in ‘n taal wat ek verstaan
- Ek ‘n kans gegun is om vrae te vra en dat my vrae voldoende beantwoord is
- Ek verstaan dat deelname aan die studie vrywillig is en dat ek nie gedruk is om deel te neem nie

- Ek verstaan dat ek mag kies om my kind se deelname ten enige tyd te staak sonder enige penalisasie of vooroordeel
- My kind van die studie onttrek mag word voor voltooiing van die projek as die studieleier voel dat dit in die kind se beste belang is

Geteken te (*plek*) .....…..…… op (*datum*) ……....…….. 2015.

....
Handtekening van ouer **Handtekening van getuie**

Verklaring deur die navorser:

Ek *(naam)* ……...…… verklaar dat:

- Ek die informasie in hierdie dokument aan ……verduidelik het.
- Ek hom/haar aangemoedig het om vrae te vra en bevredigende tyd geneem het om antwoorde te.
- Ek tevrede is dat hy/sy al die aspekte van die studie soos hierbo verduidelik verstaan
- Ek het/het nie ‘n vertaler gebruik *(As ‘n vertaler gebruik is moet hy/sy die verklaring hieronder teken*

Geteken te (*plek*) .....…..……op (*datum*) ……....…….. 2015.

....
Handtekening van navorser **Handtekening van getuie**

Verklaring deur vertaler

Ek *(naam)* ……...…… verklaar dat:

- Ek die navorser (*naam*) ……. gehelp het om die informasie in hierdie dokument aan

……..……..(*naam van ouer*) te verduidelik in

……. (*taal*).

- Ons hom/haar aangemoedig het om vrae te vra en voldoende tyd geneem het om vrae te beantwoord
- Ek ‘n feitelike korrekte weergawe weergegee het oor wat aan my voorgehou is.
- Ek tevrede is dat die ouer die inhoud van die toestemmingsbrief ten volle verstaan en dat al sy/haar vrae voldoende beantwoord is

Geteken by (*plek*) .....….....…… op (*datum*) ……...……..

....

Handtekening van vertaler **Handtekening van getuie**

Appendix 8: Parent checklist (English)

Appendix 1: PARENT CHECKLIST:

Please tick the relevant box. Please add comments on the back of the form if you feel that we need to know more.

1. Does your child take part in any of the following activities?

	Yes	No	Comments
Swimming lessons			
Ball skills (e.g. Playball)			
Mini cricket			
Tennis			
Gymnastics			
Ballet/dancing			
Karate/ Kickboxing			
Drama classes			
Art classes			
Other			

2. Did your child attend a pre-school prior to grade R?

Yes	No	Comments

3. Is your child repeating grade R?

Yes	No	Comments

4. Has your child been diagnosed with any of the following? Please tick

	Please tick	Comments
Cerebral Palsy		
Dyslexia		
Attention deficit and hyperactivity disorder (ADHD)		
Autism		
Foetal Alcohol Syndrome		
Other physical/motor disorder		

5. Has your child received any of the following therapies?

	Yes	No	Comments
Occupational Therapy			
Physiotherapy			
Speech Therapy			
Play Therapy			
Counselling			

Appendix 9: Parent checklist (Afrikaans)

Vraelys vir ouers:

Maak asb. 'n regmerkie langs die relevante antwoord. Enige verdere inligting kan agter op die vraelys bygevoeg word.

1. Neem u kind aan enige van die volgende aktiwiteite deel?

	Ja	Nee	Kommentaar
Swemlesse			
Bal vaardighede (bv. Playball)			
Mini-Krieket			
Tennis			
Gimnastiek			
Ballet/dans			
Karate/kickboxing			
Kuns klasse			
Drama klasse			
Ander			

2. Het u kind voor graad R na 'n speelskool/crèche/kleuterskool gegaan?

Ja	Nee	Kommentaar

3. Herhaal u kind tans graad R?

Ja	Nee	Kommentaar

4. Is u kind met enige van die volgende gediagnoseer?

	Merk asb.	Kommentaar
Serebrale Parese		
Dyslexia		
Aandaggebrek en hiperaktiwiteit sindroom (AGHS)		
Outisme		
Foetal Alkohol Sindroom		
Ander		

5. Het u kind die volgende ontvang of woon u kind tans enige van die volgende by?

	Ja	Nee	Kommentaar
Arbeidsterapie			
Fisioterapie			
Spraakterapie			
Spelterapie			
Sielkundige berading			

Appendix 10: Prevalence study images

Examples of the MABC-2 assessment during the prevalence study (2015)

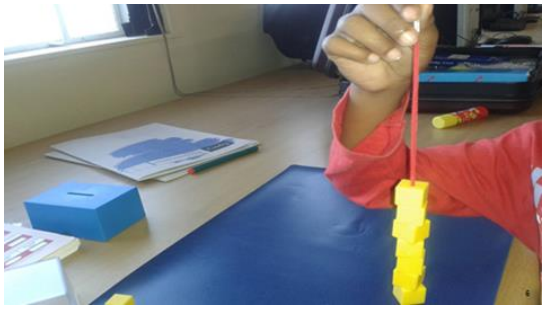


Figure 2 : The MABC manual dexterity subtest

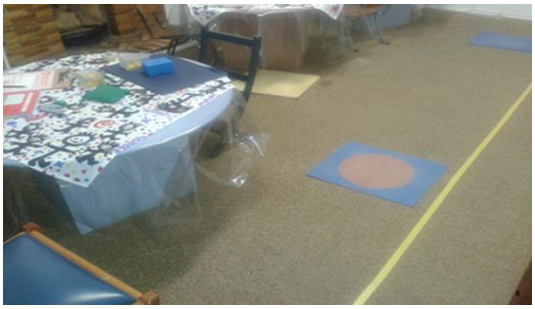


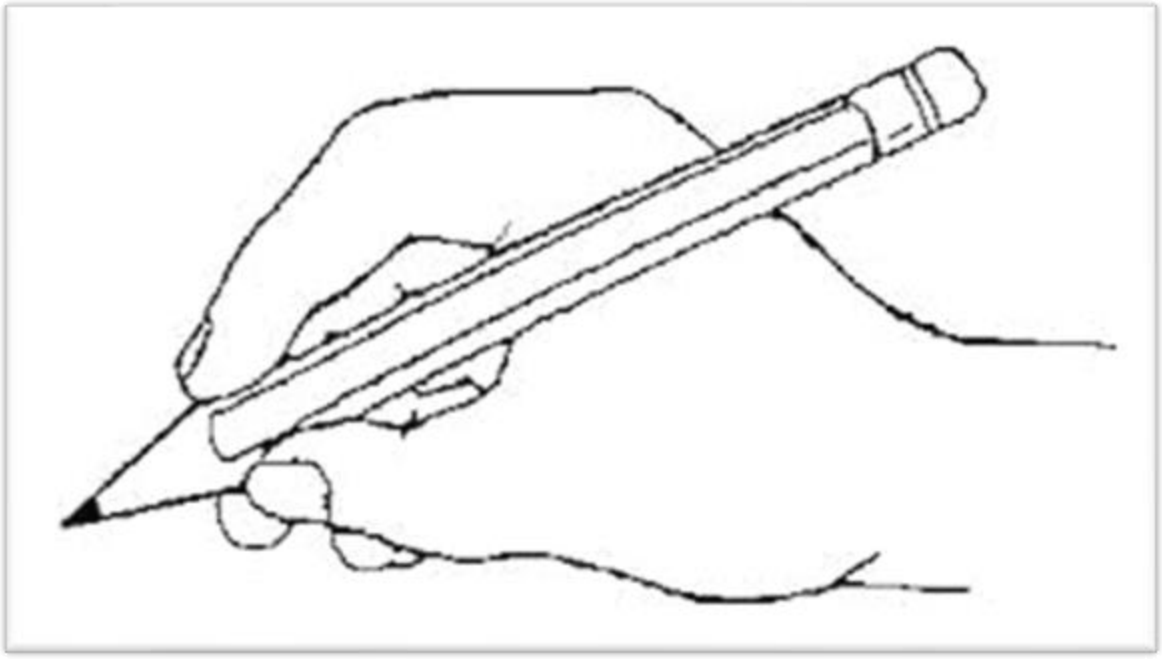
Figure 3: The MABC balance subtest

Examples of participating schools' playground areas

Figure 4: Example of an extensive grade R playground

Figure 5: Examples or playgrounds with no or limited equipment

Appendix 11: Prevalence study hand-outs



Ek leer om my potlood reg vas te hou.

Ek sit mooi regop as ek teken of eet met my voete op die vloer of op 'n kassie.

Die tafel is nie te hoog of te laag vir my nie en ek het genoeg lig waar ek sit.

Voordat ek graag 1 toe gaan wil ek leer om:

- ✓ Self my klere uit en aan te kan trek
- ✓ My trui en sokkies om te keer as dit verkeerdom is
- ✓ My skoene self uit en aan te trek
- ✓ My knopies en ritse sover moontlik self los en vas te maak
- ✓ Self toilet toe te gaan, die toilet te spoel en hande te vas
- ✓ ‘n Kraan oop en toe te draai
- ✓ ‘n Deur oop en toe te maak
- ✓ Uit ‘n glas te kan drink sonder om te mors
- ✓ Met ‘n mes en vurk te begin eet
- ✓ ‘n Boek mooi te kan hanteer en die bladsye een vir een omblaai
- ✓ Met maats te kan deel en my beurt te kan afwag
- ✓ Vir ten minste 10 minute my aandag op een takie te kan hou

Appendix 12: Example of a feedback report during the prevalence study

NAVORSINGSPROJEK VERSLAG: Name

Datum: 4 Junie 2015

Evaluasie: Movement Assessment Battery for Children – 2

Resultate:

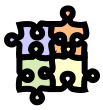
1. Hand-vaardighede: Gemiddeld vir haar ouderdom (net bo die afsnypunt)
2. Balvaardighede (gooi en mik): Gemiddeld vir haar ouderdom
3. Balans: Gemiddeld vir haar ouderdom (net bo die afsnypunt)

Die algehele telling met die toets wys dat xxxx se motoriese vaardighede onder gemiddeld is (omdat twee van die toetse se tellings aan die lae kant, so na aan die afsnypunt was). Haar ontwikkeling moet mooi gemonitor word en sy sal baat vind by ekstra oefening om hand vaardighede en balans te verbeter.

Janke Van der Walt

Arbeidsterapeut

Appendix 13: Example of advice provided to parents



FYN MOTORIESE VAARDIGHEDE

Algemene riglyne vir verbetering van fyn motoriese vaardighede

1. Maak seker dat u kind sover moontlik by 'n stoel en tafel van die regte hoogte sit om maksimale stabiliteit te verseker as hulle fyn motoriese takies uitvoer (bv. teken, eet met mes en vurk, ens.) Dit beteken: voete plat op grond (of andersins ondersteun op 'n telefoon boek/ bankie/emmer ens.). Die ruggie moet goed ondersteun word en heupe en knieë moet +-90 grade buig. Tafel moet op 'n gemaklike hoogte wees – min of meer elmboog hoogte as kind sit. As u kind by 'n groot tafel werk, maak gebruik van, bv. 'n kussing om op te sit of agter die rug vir meer ondersteuning.

2. Teken op 'n vertikale oppervlak bv. 'n esel, swartbord, witbord of papier teen muur geplak. Hierdie posisie help om die spiere rondom die skouers, elmboë en pols te ontwikkel.

3. U kind kan ook gebruik maak van 'n skryfbord of die skuins oppervlak van 'n legger, eerder as om plat op die tafel te werk om 'n beter postuur aan te moedig

4. Begin met korter oefen sessies (10 minute) en maak langer soos motivering beter raak

Voorbeelde van aktiwiteite:

1. Speel met klei of speel-deeg – knyp, rol, druk vormpie uit, ens. Oefen sommer ook om mes en vurk te gebruik met klei.
2. In bad/waterkom: speel met sponsies en "squeezy" bottles of speelgoed. Gooi water van een houer na 'n ander of druk om water uit te spuit.
3. Trek poppe of teddies aan en uit – sluit verkieslik knope, hakies, zips ens in.
4. Skeur papier met verskillende teksture in klein stukkies om 'n collage te maak
5. Gebruik verskillende teksture om met hande en vingers in te teken en skryf bv. skeerroom, sand, rys, meel ens.
6. Pop "bubble wrap" papier met vingers.
7. Gebruik stensils en teken rondom deksels ens om prente te maak
8. Inkleur
9. Aktiwiteit boeke met dot-to-dots, "mazes", ens
10. Legkaarte - begin klein sodat u kind sukses kan ervaar. Maak eie legkaarte deur prente in 'n paar stukke te knip en weer aan mekaar te "bou".
11. Vinger verf sowel as verf met kwassies. 'n Bietjie meel/mieliemeel met water en kleursel maak 'n lekker vingerverf.
12. Knyp wasgoed pennetjies vas rondom 'n papierbord om bv. 'n leeu se maanhare of snaakse gesiggie te maak.
13. Knip verskillende teksture – strooitjies, papierborde, koerante, ens. Oefen om rondom verskillende vorms te knip.
14. Eenvoudige papier vou aktiwiteite bv. papier vliegtuig, hoed, ens.

15. Ryg kraletjies/paste van verskillende grotes. Pasta met groterige gaatjies aan 'n skoenveter werk goed.
16. Kaart speletjies bv. SNAP
17. Lego of ander konstruksie speletjies
18. Kyk hoe vinnig hy/sy skuifspelde (paperclips) aanmekaar kan konnekteer om 'n string te maak
19. Speel "kantoor" speletjies waar hy/sy 'n krambinder/ gaatjies drukker kan gebruik, briewe vou en in koeverte sit, ens.
20. Enige bak en brou aktiwiteite. Modderkoekies werk ook goed!
21. Albaster spel. Probeer om albaster met duim en wysvinger te skiet na 'n teiken.
22. Tel knopies/krale/pasta stukkies op met tweezer en plaas in houer. Kyk hoeveel hy/sy in 'n seker tyd kan doen
23. Plakkers ("stickers" plak in patrone, sticker boeke, ens)
24. GENIET DIT

Verbetering van groot motoriese vaardighede

Die volgende aktiwiteite is voorbeelde van spel wat algemene groot motoriese vaardighede en balans kan verbeter

- Bal spel. Gebruik balle van verskillende groottes. Opgerolde kouse werk ook goed Gooi en vang in verskillende posisies. Bv. staan op knieë, staan op een been.
- Bal en raket speletjies
- Hopscotch – trek blokke in sand of met bordkryt op steen. Hop en spring in verskillende patrone
- Oefen spring patrone (star-jumps ens).
- Probeer om met 'n springtou te spring
- Kniel op hande en knieë. Lig nou om die beurt stadig een arm en dan een been op 'n slag. Probeer om die posisie te hou sonder om om te val. Probeer nou die linker arm en regter been saam lig, en dan omgekeerd.
- Oefen om op 'n reguit lyn/lae muurtjie te loop sonder om "af te val"
- Bou 'n interessante hindernisbaan en probeer om oor en deur hindernisse te klim sonder om daaraan te raak.
- Oefen om op een been te hop.
- Probeer bolmakiesie slaan
- Rol om en om
- Loop soos 'n leeu/spring soos 'n padda/kangaroo, ens.
- Algemene spel bv. aan-aan, sokker, rugby, netbal

Appendix 14: Summarised report to WCED

Summary of findings: The prevalence of motor skill impairment in grade R learners in mainstream public schools in the West Coast district of South Africa

Introduction:

Motor impairment has been reported in children with HIV, FAS, CP, DCD, ADHD etc. and given that fine motor skills together with executive functioning are good predictors of academic performance, many children in grade R in in the West Coast district may present with potentially significant motor impairment and not be ready for mainstream academic activities. The aim of this study was to determine the prevalence of motor impairment in grade R learners in mainstream West Coast District schools. A cross-sectional descriptive study design using multistage cluster sampling was used to identify 6 participating schools. 150 learners (5 – 6 years) were tested using the Movement Assessment Battery for Children 2.

Preliminary analysis and findings:

1. When compared to international statistics available for the prevalence of DCD (Developmental Coordination Disorder) which is between **5 – 13 %,** the prevalence of significant motor impairment in the West Coast is high, as indicated in Figure 1. The total score indicates the cumulative score for manual dexterity (fine motor skills), aiming and catching (ball skills/eye-hand coordination) and balance. The score below the 15th percentile includes those children with definite significant difficulties and those with a high risk of developing significant difficulties with a prevalence of **14.5%.** The prevalence of children with manual dexterity difficulties was very high at **24.6%,** as was the prevalence of children with balance difficulties at **18.1%.** The prevalence of children with aiming and catching difficulties was low at **4.3%.**
2. Statistical analysis indicated that boys are more likely to have difficulties with manual dexterity than girls
3. Children attending schools with limited or no playground apparatus had significantly more difficulties with manual dexterity and balance than those attending schools with an extensive playground.
4. Children attending no-fee schools had significantly more difficulties with manual dexterity and balance, than those attending schools where a fee was paid.
5. Children with a lower weight and height had significantly more difficulties with manual dexterity, with low weight being the most important indicator.

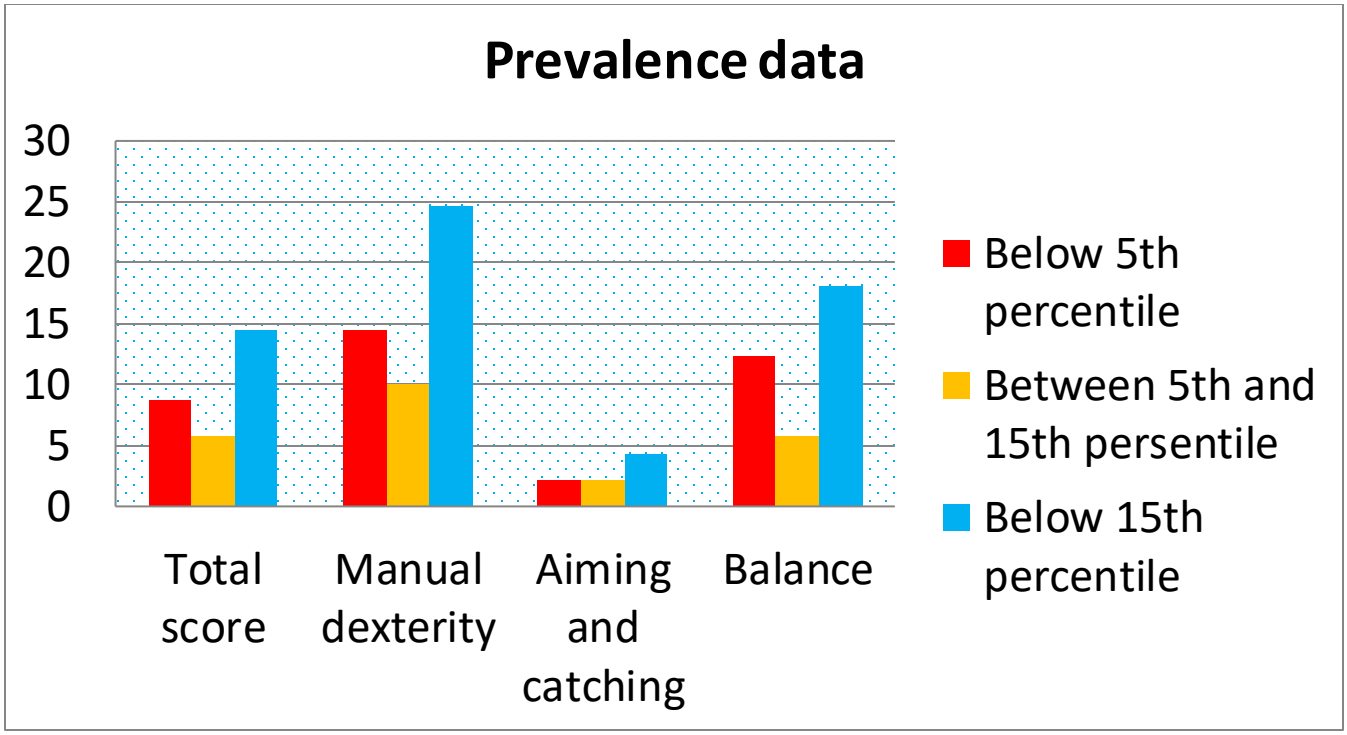


Figure 3

Conclusions:

There is a high prevalence of motor skill impairment under grade R pupils in the West Coast of South Africa. The prevalence of manual dexterity difficulties is particularly high and will have implications on the school readiness and academic progress of these children.

Further investigation into the relationships between motor skills and fee vs no fee schools, playgrounds and weight of children is recommended.

This study motivates the need for further research into appropriate interventions to address motor skill impairment in pre-school children.

Appendix 15: Scoping Review Table

Table 2: Frequency and duration of programmes and sessions according to approaches

Approach	Description	Studies (N)	Total number of sessions				Time length of session in minutes				Duration of programme in weeks				Number of sessions per week			
			Mean	Standard Deviation	Median	Range	Mean	Standard Deviation	Median	Range	Mean	Standard Deviation	Median	Range	Mean	Standard Deviation	Median	Range
Visual perceptual motor	The development of gross and fine motor skills in combination with spatial awareness through practice, using age appropriate activities. For the purposes of this review it encompasses the terms psychomotor training.	30	25.63	12.77	23	5 - 72	57.00	43.61	45	10 - 240	17.41	10.20	13	6 - 40	2.17	1.18	2.00	1 - 5
Sensory Integration	The use of sensory input, including vestibular and proprioceptive stimulation to prompt an adaptive response in order to enhance the organisation of neurological processes involved with motor planning and motor learning.	15	36.25	21.51	32	8 - 130	47.25	12.27	46	20 - 75	20.58	10.14	20	6 - 52	1.92	0.90	2.00	1 - 5
Task specific training	The repetitive practice of a meaningful motor skill-based activity that is specific to an intended outcome.	13	17.08	8.32	17	3 - 72	40.86	14.57	38	10 - 75	10.42	4.17	10	3 - 30	1.85	0.88	2.00	1 - 5
Physical Education or classroom activities	Physical activities and games used in school in which students receive instruction and practice in physical exercise in order to promote good health.	9	42.25	32.74	33	5 - 120	75.13	70.25	50	10 - 240	17.33	8.31	15	8 - 40	2.81	1.51	2.50	1 - 5

Approach	Description	Studies (N)	Total number of sessions				Time length of session in minutes				Duration of programme in weeks				Number of sessions per week			
Indirect intervention	Therapy input through means of teacher/parent consultation, monitoring, training and provision of programmes rather than direct treatment input with the child.	7	38.33	41.41	28	5 - 120	39.60	12.28	38	20 - 75	22.40	8.20	24	13 - 32	2.00	2.00	1.00	1 - 5
Mastery	A method of instruction, associated with leaner autonomy. The facilitator creates a learning environment and supports the learners to set their own motor learning goals and take charge of their own learning.	5	22.00	8.19	24	13 - 68	44.00	13.89	37	30 - 60	13.50	1.29	14	12 - 35	2.25	1.26	2.00	1 - 5
Cognitive motor	A problem solving approach which is child-centred and performance based and enables the child to develop new skills through a process of strategy use and guided discovery.	4	29.00	13.53	30	8 - 72	55.67	7.51	60	30 - 60	21.67	13.20	19	10 - 40	2.25	1.26	2.00	1 - 5
Neuromotor Task Training	A goal directed physiotherapy approach where emphasis is placed on the interaction between the child, the task and the social and physical environment, with the aim being the achievement of a desired movement goal.	4	31.50	35.11	15	5 - 112	33.13	3.75	33	10 - 60	14.75	9.03	11	9 - 28	1.88	0.85	1.75	1 - 5

Approach	Description	Studies (N)	Total number of sessions				Time length of session in minutes				Duration of programme in weeks				Number of sessions per week			
Rhythm, timing, planning	Specific emphasis is placed on the rhythm and timing element of movement. It includes the Le Bon Depart technique (a form of psychomotor therapy in which music and rhythm play a prominent role).	3	17.50	3.54	18	15 - 20	60.00	0.00	60	60 - 60	12.50	3.54	13	10 - 15	1.33	0.58	1.00	1 - 2
Virtual gaming	Virtual gaming: The application of a three-dimensional (3-D) artificial environment to computer games with a movement element.	3	16.67	4.16	18	5 - 48	31.67	2.89	30	10 - 60	9.67	3.51	10	6 - 24	2.17	0.76	2.00	1.5 - 5
Direct Instruction	A teacher-directed method of instruction through the use of straightforward, explicit teaching techniques, usually to teach a specific skill.	2	29.00	*	29	16 - 68	37.00	*	37	30 - 60	14.50	0.71	15	14 - 35	2.00	*	2.00	2 - 4
Motor Imagery	[Motor Imagery: The mental execution of a movement without any actual physical movement. This approach is used in combination with actual practice, to stimulate the ability to use the knowledge of the relation between vision and movement.	2	13.50	2.12	14	5 - 48	41.00	8.49	41	10 - 60	11.50	2.12	12	10 - 24	1.75	0.35	1.75	1.5 - 5
Pharmaceutical	The administration of prescribed medication to usually address concentration difficulties, hyperactivity and anxiety.	2	Medication provided according to individual needs. : Concerta (dosis unknown); Ritalin (10 – 20 mg). Time length for one trial was 1 – 2 weeks															
Equestrian	Therapeutic use of horses to promote motor skills.	1	12.00	*	12	12 - 12	45.00	*	45	45 - 45	12.00	*	12	12 - 12	1.00	*	1.00	1 - 1

Approach	Description	Studies (N)	Total number of sessions				Time length of session in minutes				Duration of programme in weeks				Number of sessions per week			
Body-function orientated	Body-function orientated: Therapeutic input aimed at treating specific areas of body-function e.g. muscle strengthening or ocular-motor control.	1	12.00	*	12	5 - 48	35.00	*	35	10 - 60	13.00	*	13	13 - 24	1.50	*	1.50	1.5 - 5
TOTAL			**24**	**17**	**22**	**3 - 130**	**46**	**17**	**42**	**10 - 240**	**15**	**6**	**14**	**3 - 40**	**2**	**1**	**2**	**1 - 5**

Appendix 16: Delphi study invitation and consent (email)

Invitation to take a survey to participate in the development of a motor skill programme for pre-school children

From: Janke van der Walt (surveys@sun.ac.za)

To:janke@vanderwalt.net

Date: Tuesday, 23 April 2019, 12:52 GMT+2

You have been invited to take the survey: Development of a motor skill intervention for grade R children in the West Coast of South Africa: a multidisciplinary and international collaboration.

Please consider the following background information when completing the questionnaire: The West Coast education district of South Africa is a vast region (31,119 km2 in size) housing both urban and rural areas. The region has many challenges, under more poverty, low-income, high levels of unemployment and poor levels of education in the community. The main health concerns in the area are HIV/AIDS, Tuberculosis (TB) and malnutrition. Alcohol and drug abuse are other huge concerns with a high prevalence of Foetal Alcohol Syndrome (FAS). There are 96 government primary schools with grade R classes in the West Coast education district. The number of learners in grade R varies from as low as seven to 150 per school, with an average number of 41 per class. Grade R classes typically have one teacher and in some cases a teaching assistant. Health and educational therapy services are thinly spread and treatment is very limited due to time, distance, space and resource restraints. Private services are limited to urban areas and inaccessible to many due to economical and practical issues (e.g. transport).

A recent prevalence study (2016) indicated a very high incidence of significant motor skill difficulties (14.5 %) under grade R pupils in the West coast of South Africa, with the incidence of significant fine motor difficulties very high at 24.6% and balance difficulties at 18.1%. Statistical analysis indicated that no access to playground equipment, attendance to a no-fee school and low weight were associated with a higher prevalence of motor skill difficulties. The first step to develop an intervention to address the problem was a scoping review, which resulted in a list of key concepts that made other interventions successful.

This Delphi study aims to build on the scoping review by consulting multidisciplinary and internationally in order to develop a motor skill intervention for schools in the West Coast area of South Africa. On completion, the proposed study will be piloted and tested in at least 2 schools in the area.

Your participation in this survey is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part. This study has been approved by the Health Research Ethics Committee at Stellenbosch University and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research. Your participation will involve responding to questions or statements via the link below to contribute to the development of a comprehensive and feasible programme. After the data from the first round is analysed, a second and possibly third and fourth round of questions will be sent to you. It will take about **10 - 15 minutes** of your time for each round to answer the questions. Your responses will be used to formulate the questions or statements of the next round of questions, but your details will be kept confidential. You will also be able to see the evolvement of statements, which may be beneficial to your own professional practice or career. You will not be paid to take part in the study and there will be no costs involved for you, if you do take part. Please contact Janke Van der Walt (Janke@vanderwalt.net) if you have any further queries or encounter any problems. You can contact the Health Research Ethics Committee at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed Please click on the link below to consent to the above and take the survey https://sunsurveys.sun.ac.za/Motor-skill-intervention-for-grade-R-a-Delphi-study.survey?test=true&i=66a59e74eb4f4f5abfca447cf80723bd

Click here to take the survey.

Appendix 17: Ethics approval letter following lapse in ethics approval

UNIVERSITEIT STELLENBOSCH UNIVERSITY

Approval Letter
Amendment

11/09/2019

Project ID: 3482

Ethics Reference No: S16/10/190

Project Title: The development of an early intervention programme to improve motor skills and academic performance of grade R pupils in government schools in the West Coast of South Africa

Dear Ms Janke Van der Walt,

Your amendment request dated 18 August 2019 and submitted on 02 September 2019 refers.

The Health Research Ethics Committee (HREC) reviewed and approved the amended documentation through an expedited review process.

The following amendments were reviewed and approved:

1. Amended protocol version 3.0 dated 28 August 2019
2. HREC Letter of re-consent to Delphi participants version 1.0 dated 28 August 2019
3. Delphi study questions round 1 version 1.0 dated 28 August 2019.

With this amendment approval, the annual renewal of ethics approval for the research project is extended for one year as follows:

Approval Date: 11 September 2019

Expiry Date: 10 September 2020

Kindly be reminded to submit progress reports two (2) months before expiry date.

Where to submit any documentation

Kindly note that the HREC uses an electronic ethics review management system, *Infonetica*, to manage ethics applications and ethics review process. To submit any documentation to HREC, please click on the following link: https://applyethics.sun.ac.za.

Please remember to use your Project ID [3482] and ethics reference number [S16/10/190] on any documents or correspondence with the HREC concerning your research protocol.

Yours sincerely,

Mr. Francis Masiye,

HREC Coordinator,

Health Research Ethics Committee 2 (HREC2).

National Health Research Ethics Council (NHREC) Registration Number:

REC-130408-012 (HREC1) REC-230208-010 (HREC2)

Federal Wide Assurance Number: 00001372
Office of Human Research Protections (OHRP) Institutional Review Board (IRB) Number:
IRB0005240 (HREC1) IRB0005239 (HREC2)

The Health Research Ethics Committee (HREC) complies with the SA National Health Act No. 61 of 2003 as it pertains to health research. The HREC abides by the ethical norms and principles for research, established by the World Medical Association (2013). Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects; the South African *Department of Health (2006). Guidelines for Good Practice in the Conduct of Clinical Trials with Human Participants in South Africa (2nd edition)*; as well as the Department of Health (2015). Ethics in Health Research: Principles, Processes and Structures (2nd edition).

Page 1 of 2

Appendix 18: Re-consent letter to Delphi participants (email)

Dear participant

Re: Delphi study - Development of a motor skill intervention for grade R children

Thank you for your valued participation in the above study by responding to the invitation to complete a survey.

The study was approved by the Health Research Evaluation Committee and the Ethics Committee of the Faculty of Medicine and Health Sciences (HREC), Stellenbosch University in 2017. There was however a lapse in ethical approval due to the researcher's failure to send in an annual progress report as stipulated by the HREC. This means that the survey was distributed without renewal of ethical approval.

In order to use the collected data when analysing and reporting the research, re-consent from participants is needed. Participants are under no obligation to re-consent and data will only be used if participants do re-consent. Please note that no harm was caused to participants in failing to renew the ethics approval. The researcher apologises for any inconvenience caused to you.

Please contact Janke van der Walt at janke@vanderwalt.net if you have any concerns of questions or the HREC at 021-938 9207

Please click on the link below to re-consent to this study

https://sunsurveys.sun.ac.za/Reconsent-Development-of-a-motor-skill-intervention-for-grade-R-children-in-the-West-Coast-of-South-Africa-a-multidisciplinary-and-international-collaboration.aspx?i=40595bf45f6d4149a6a5530df121466b

Appendix 19: Delphi study first round survey

Development of a motor skill intervention for grade R children in the West Coast of South Africa: a multidisciplinary and international collaboration

What is your age?

_____

What is your field of occupation?

- 1. Occupational Therapy
- 2. Physiotherapy
- 3. Teaching (with physical education responsibility)
- 4. Teaching (without physical education responsibility)
- 5. Child kinetics/Kinesiology
- 6. Teaching assistant

What is your highest qualification?

- 1. Diploma
- 2. Bachelors Degree
- 3. Honours Degree
- 4. Masters Degree
- 5. Doctoral degree

How many years of experience do you have working with minors (ages 0 - 18 years)?

_____

Have you been an author or co-author of an article published in a peer-reviewed journal?

- ○ 1. Yes
- ○ 2. No

In which country do you work with children?

_____

Which option best describes the geographical area that you are working in?

- ○ 1. Urban main place: city or large town
- ○ 2. Urban main place informal: informal settlement near city or town
- ○ 3. Urban area: small town
- ○ 4. Urban area informal: Informal settlement near small town
- ○ 5. Rural area: Farm
- ○ 6. Rural informal: Informal settlement on a farm

Which option/s best describe the setting that you are working in? Choose one or more options.

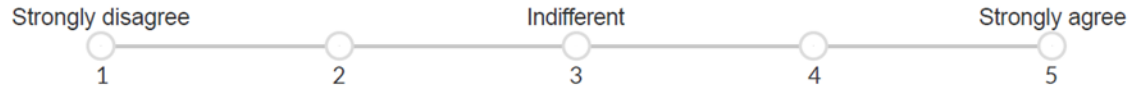
- ☐ 1.University - academic e.g. lecturer or research
- ☐ 2.Educational - schools
- ☐ 3.Private setting e.g. private clinic or gym
- ☐ 4.Health setting - hospital
- ☐ 5.Other:

With which of the following conditions have the children that you work with been diagnosed? Choose one or more options.

- ☐ 1.Developmental Coordination Disorder (DCD)
- ☐ 2.Attention Deficit and Hyperactivity Disorder (ADHD)
- ☐ 3.Autism Spectrum Disorder (ASD)
- ☐ 4.Language disorders
- ☐ 5.Foetal Alcohol Syndrome (FAS)
- ☐ 6.HIV/Aids
- ☐ 7.Sensory Processing Disorder (SPD)
- ☐ 8.Down Syndrome
- ☐ 9.Intellectual Impairment
- ☐ 10.Malnutrition
- ☐ 11.Dyslexia
- ☐ 12.Motor Skill difficulty not otherwise specified
- ☐ 13.Other:

Please add any further information about your experience, qualifications or work situation that you feel may be important in relation to the study

To which extent do you agree with this statement: Some form of therapeutic intervention is essential to improve the motor skills of children who have significant motor skill difficulties.



Please explain your answer:

The scoping review identified the following role players involved in motor skill interventions for pre-school children. Rank these from 1 – the most important role player to 6 – the least important role player

Occupational Therapist _____

Physiotherapist _____

Kinesiologist _____

Teacher (without physical education role) _____

Teacher with physical education role _____

Teaching assistant _____

Who should be the main facilitator of a motor skill intervention programme? Rank the following professionals in order of importance. Rank the most preferred role player as 1 and the least as 6

Occupational therapist _____

Physiotherapist _____

Teacher (without physical education role) _____

Teacher with physical education role _____

Kinesiologist _____

Teaching assistant _____

Who should assist in facilitating a motor skills intervention? Rank the professionals in order of importance. Rank the most preferred role player as 1 and the least as 6

Occupational Therapist _____

Physiotherapist _____

Teacher (without physical education role) _____

Teacher with physical education role _____

Kinesiologist _____

Teaching assistant _____

Who should play an advisory role to the the facilitators of a motor skill intervention? Rank the professionals in order of importance.Rank the most preferred role player as 1 and the least as 6

Occupational Therapist _____

Physiotherapist _____

Teacher (without physical education role) _____

Teacher with physical education role _____

Kinesiologist _____

Teaching assistant _____

The scoping review indicates that a successful motor skill intervention for pre-school children can be carried out as an individual or group intervention. What do you think is the best option?

- 1. Individual session
- 2. Group session
- 3. Group and individual sessions

Please explain your answer:

The scoping review identified typical therapy group sizes of between 3 and 12 children, with an average of 5 children per group. What is the maximum number of children you think should be in an intervention group?

The scoping review indicates that a successful intervention programme can be delivered either in a school or therapy environment. Where do you think an intervention programme for pre school children should be implemented?

- ○ 1. School
- ○ 2. Therapy Centre
- ○ 3. Both

In the West Coast of South Africa, grade R classes have an average of 41 children per class. When implementing an intervention in the school environment, which of these children should be included in such an intervention?

- ☐ 1.Only children with significant motor skill difficulties
- ☐ 2.All the children in the class
- ☐ 3.All children in a class should be included, but children with significant difficulties should be grouped separately
- ☐ 4.Other:

Please explain your answer:

In which quarter of a school year should a motor skill intervention programme start? Please rank your choices with 1 as the most preferred option and 4 as the least preferred option.

First quarter _____
Second quarter _____
Third quarter _____
Fourth quarter _____

Please explain your answer

Studies in the scoping review indicated that successful motor skill interventions most frequently were from 8 - 10 weeks in duration. What is your recommendation (in weeks) for the duration of a motor skill intervention?

_____

Successful intervention programmes in the scoping review most frequently carried out two sessions per week. How many intervention sessions per week would you suggest?

_____

The scoping review indicates an average of 45 minutes per session for a motor skill intervention. How long do you think should a session be in minutes?

_____

Research indicates that an indirect and child centered approach have a more positive effect than a direct teaching approach .Do you agree with the following descriptions of these approaches? You can tick one or more options.

- [ ] 1.The activities used in a motor skill intervention should be guided by the child's interests
- [ ] 2.The child should assist with goal setting
- [ ] 3.The child should be provided with choices during motor skill interventions
- [ ] 4.Intervention should take place though means of facilitation rather than teaching
- [ ] 5.There should be clear boundaries and rules
- [ ] 6.Other:

The scoping review identified 12 approaches used in successful interventions to address motor skill difficulties. Which of the following approaches would you use when developing a motor skill intervention for children living in the West Coast of SA? Choose all that you would include/use.

- [ ] 1.Visual-perceptual motor approach
- [ ] 2.Sensory integration approach
- [ ] 3.Indirect approach (including training, giving advice and feeding into the individual education plan of children)
- [ ] 4.Task specific training
- [ ] 5.Cognitive-motor approaches
- [ ] 6.Mastery
- [ ] 7.Approaches focusing on rhythm and timing
- [ ] 8.Medication
- [ ] 9.Neuro-motor task training
- [ ] 10.Use of virtual gaming
- [ ] 11.Equestrian therapy (Horse riding)
- [ ] 12.Input through physical education or normal class activity in schools
- [ ] 13.Other:
- [ ] 14.None Of The Above

Evidence suggests that activities aimed at improving gross motor skills have a positive influence on both gross and fine motor skills. Where you think the main focus should be when choosing the activities for a motor skill intervention?

- ○ 1.
  Fine motor based play and activities
- ○ 2.
  Gross motor based play and activities
- ○ 3.
  Both fine and gross motor activities

Please add any other comments or suggestions here:

Thank you for you valuable contribution to this survey.

You will receive a summary of results and a follow-up survey in 3 -6 weeks' time.

Appendix 20: Delphi study second round survey

Round 2: Development of a motor skill intervention for grade R children in the West Coast of South Africa: a multidisciplinary and international collaboration

* **1. Survey participants agreed that a motor skill intervention should preferably be implemented in the first two quarters of a school year. Please choose from the following options the suggestions that are most likely to help with early identification of motor skill difficulties to enable a therapist/teacher to set specific aims for an intervention**

- ☐ 1.A motor skill checklist devised for grade R pupils
- ☐ 2.Teacher training to guide the use of a motor skill checklist
- ☐ 3.A written guide to accompany a motor skill checklist
- ☐ 4.A specific assessment toolkit should accompany a checklist
- ☐ 5.A checklist without a specific toolkit, but with a list of typically available equipment to use in a grade R class
- ☐ 6.All children should be assessed by a qualified therapist
- ☐ 7.Children with difficulties as identified by a checklist can be referred to a therapist for more in-depht assessment
- ☐ 8.No specific evaluation is needed prior to the intervention, but difficulties children experience should be noted during the programme
- ☐ 9.Other:

2. Do you have any suggestions of readily available and affordable checklists suitable for screening gross motor skills and for use in a school environment? Please comment.

* **3. How should the aims of the intervention programme be determined?**

- [ ] Aims identified for each individual child
- [ ] Aims identified for the specific group of children
- [ ] General aims according to the expected developmental milestones of the child/children
- [ ] Other:

* **4. Participants in round one agreed that treatment for motor skill difficulties can take place as individual or group sessions and depends on the level of difficulty a child experiences and the availability of resources.**

Taking into account the high prevalence of motor skill difficulties and limited therapeutic resources in the West Coast area, please indicate what you think would be the best option:

- [ ] Individual sessions
- [ ] Group sessions
- [ ] Individual and group sessions
- [ ] Group sessions but with clear guidance and a clear referral pathway for children who may need individual sessions
- [ ] Other:

5. Optional: Please comment

* **6. The most important role players with regards to facilitation of a motor skill programme were identified as**

Teacher with physical education experience
Occupational Therapist
Physiotherapist.

Taking into account the vastness of the West Coast area and limited resources, please rate you agreement with the following statement:

The role of a facilitator could be played by any one of the above mentioned role players according to availability and experience

Strongly disagree		Indifferent		Strongly agree
1	2	3	4	5

* **7. The most important role players with regards to assisting the facilitatorof a motor skill programme were identified as**

Teacher with physical education experience
Teaching assistant
Class teacher

Please rate your agreement with the following statement: The role of an assistant could be played by any one of the above mentioned role players according to availability and experience

Strongly disagree		Indifferent		Strongly agree
1	2	3	4	5

* **8. The most important role players with regards to providing training, guidance and advice to the facilitators of a motor skill programme were identified as**

Occupational Therapist
Physiotherapist
Childkinetica practitioner

Please rate your agreement with the following statement: Taking into account the vastness of the West Coast area and limited resources, this role could be played by any one of the above mentioned role players according to availability and experience

Strongly disagree		Indifferent		Strongly agree
1	2	3	4	5

9. Optional: Please add any further comments or suggestions regarding the role players in a motor skill intervention programme

* **10. Participants agreed that a group should consist of 5 - 8 children, but consensus was not reached on who to include and how to group children together. Please consider the following comments of participants in round one of this study before choosing one of the options.**

- Integrated groups will avoid stigmatism
- Separate groups provide opportunity for practice on each child's own level
- Typically developing children may be bored if included
- Children with difficulties will stand out if everyone is included
- Children could be grouped separately according to difficulties at first, but later be merged together as children progress
- All children should be included but differentiation of strategies is important
- All developing children will benefit and it is a way to identify difficulties

- [ ] 1.Only children with significant motor skill difficulties should be included
- [ ] 2.All children in a class should be included, but children with significant difficulties should be grouped separately
- [ ] 3.All children in a class should be included

* **11. Participants agreed on an 8 - 12 week programme (roughly 2 terms) with 2 sessions per week. Considering that the children in the group will be aged 5 - 7 years and that the sessions will take place during school hours, how long do you think each session should be. Choose one option.**

- [ ] 1.30 minutes
- [ ] 2.45 minutes
- [ ] 3.60 minutes

12. Please add any further comments or suggestions here

Thank you for completing this survey.

You will receive a follow-up e-mail or survey within 3 - 6 weeks of completion of the survey.

Appendix 21: Delphi study third round survey

Round 3 Development of a motor skill intervention for grade R children in the West Coast of South Africa: a multidisciplinary and international collaboration

* **1. .The West Coast of South Africa is a vast area with 97 government primary schools with grade R classes. The number of grade R learners per school vary from 7 to 150. Survey participants agreed that a motor skill intervention group should consist of 5 - 8 learners.**

Considering the information above, who do you think should be included in the motor skill groups?

Please choose one of the following options

- ☐ Only children with significant motor skill difficulties should be included
- ☐ All children in a class should be included, but children with significant difficulties should be grouped separately
- ☐ All children in a class should be included
- ☐ Only children with significant motor skill difficulties should be included for a pilot study to test the programme before considering inclusion of the whole class

2. How should the aims of the intervention programme be determined?

- ☐ Aims identified for a specific group of children
- ☐ General aims according to expected developmental milestones
- ☐ Specific aims for each individual child

3. Please add any final suggestions or comments here

Appendix 22: Ethics approval following annual ethics progress report

UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

Approval Letter
Progress Report

23/07/2020

Project ID: 3482

Ethics Reference No: S16/10/190

Project Title: The development of an early intervention programme to improve motor skills and academic performance of grade R pupils in government schools in the West Coast of South Africa

Dear Ms Janke Van Der Walt

We refer to your request for an extension/annual renewal of ethics approval dated 03/07/2020.

The Health Research Ethics Committee reviewed and approved the annual progress report through an expedited review process.

The approval of this project is extended for a further year.

Approval date: 11 September 2020

Expiry date: 10 September 2021

Kindly be reminded to submit progress reports two (2) months before expiry date.

Where to submit any documentation

Kindly note that the HREC uses an electronic ethics review management system, *Infonetica*, to manage ethics applications and ethics review process. To submit any documentation to HREC, please click on the following link: https://applyethics.sun.ac.za.

Please remember to use your Project Id 3482 and ethics reference number S16/10/190 on any documents or correspondence with the HREC concerning your research protocol.

Yours sincerely,

Mrs. Ashleen Fortuin
Health Research Ethics Committee 2 (HREC2)

National Health Research Ethics Council (NHREC) Registration Number:
REC-130408-012 (HREC1)•REC-230208-010 (HREC2)

Federal Wide Assurance Number: 00001372
Office of Human Research Protections (OHRP) Institutional Review Board (IRB) Number:
IRB0005240 (HREC1)•IRB0005239 (HREC2)

The Health Research Ethics Committee (HREC) complies with the SA National Health Act No. 61 of 2003 as it pertains to health research. The HREC abides by the ethical norms and principles for research, established by the World Medical Association (2013). Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects; the South African Department of Health (2006).Guidelines for Good Practice in the Conduct of Clinical Trials with Human Participants in South Africa (2nd edition); as well as the Department of Health (2015). Ethics in Health Research: Principles, Processes and Structures (2nd edition).

The Health Research Ethics Committee reviews research involving human subjects conducted or supported by the Department of Health and Human Services, or other federal departments or agencies that apply the Federal Policy for the Protection of Human Subjects to such research (United States Code of Federal Regulations Title 45 Part 46); and/or clinical investigations regulated by the Food and Drug Administration (FDA) of the Department of Health and Human Services.